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The Institute of Vitreous Enamellers

The Welsh Engineers' and Founders' Association

and

The Foundry Trades' Equipment and Supplies Association

Institute of British Foundrymen

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J. Hepworth, J.P., M.P., "Ingle Nook," Bolton Road, Bradford.

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The Registered Office and Laboratories of the B.C.I.R.A. are:—
21-23, ST. PAUL'S SQUARE, BIRMINGHAM
Telephone: Colmore 4274-4275 *Telegrams: CIRA*
The B.C.I.R.A. Scottish Laboratories are:—
Foundry Technical Institute, Meek's Road, Falkirk
Telephone: 332

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An International Foundry Dictionary

Many technicians within the foundry industry are just awakening to the fact that the Comité International des Associations Techniques de Fonderie has to be taken seriously. For a period of years its sole function appeared to be the organisation of a programme of international foundry congresses, yet those actually participating in its work at a very early stage sought to evolve from its constitution such activities as could only be done effectively by such a body. Being a democratic association, results shape themselves but slowly, and it was in the very early days that Mr. España, who represented Spain, made a plea for the creation of a technical dictionary of an international character for use by foundrymen. The idea was taken up enthusiastically by the nations whose foundry literature was relatively meagre—Czecho-Slovakia, Poland, and to a less extent Italy. Less enthusiasm was exhibited by France, Germany, Belgium, Holland, United States and the United Kingdom, as within those countries adequate ways and means existed of assimilating the technical Papers of the world. With the passage of time, and the intensive development of the foundry industry all over the world, greater support was given by all countries. The work of the Committee has been so directed that a massive tome of equal use to all nations is not envisaged, but data have been assembled, numbered and defined (in French) and, where possible, the equivalent word in each language has been found and listed. Thus it is now possible for each nation to publish from the data so accumulated its own dictionary. The first country to avail itself of complete publication in book form is France, though Italy is performing the same task serially in one of its technical magazines. The Association Technique de Fonderie is to be congratulated on its enterprise, and the most striking feature—a completely new departure to the best of our knowledge—is a complete segregation of American and English technological nomenclature. There is a section of the literary world which is, for the sake of clarity of expression, enthusiastic on the subject of "standard English," by means of which the vocabulary is reduced to a minimum, while still enabling one to give full expression to one's thoughts. We give full approbation to this system when translation into a foreign language is anticipated, but not when domestic consumption is envisaged. The various words currently used in the English language for the global term "slag" often carry a well-understood significance which adequately delineates a condition difficult of expression adjectively. A study of this dictionary under consideration reveals a number of defects, which no doubt a second edition will eliminate. We were surprised at the French definition of "castine," which to our mind is a perfect description of the French word "fondant." As a result, and because of the definition, the English equivalent has been given as "flux." "Castine" in our experience of practical working in French foundries is definitely "limestone," whereas a "fondant" can be anything, including "castine" used as a "flux." A striking defect is the total absence of a contents list, and it is by wading through the book that we are able to say that the languages covered include French, German, American, English, Spanish, Italian, Polish, Portuguese and Czecho-Slovak. It is a pity that the first numbered words (001)—"abreuver" in French and "vent wire" in English—have no possible association.

It must not be thought that these criticisms are anything other than minor ones, for primarily the dictionary is meant for French use exclusively, and it is up to the British (if they deem the work and expense worth while) to produce their own work of reference from the data so far established, which is well capable of being extended to embrace other words as international co-operation is assured. When the British undertake their work of definition of terms, difficulties immediately arise owing to variations in usage in either different branches of the industry or localities. The word "sound" as related to a casting is almost exclusively confined to soundness under pressure test by those firms having their product so tested, whereas to a general jobbing foundry the significance would be that its external appearance was such as to ensure the satisfaction of the user. The foundry metallurgist regards a sound casting as one which is free from internal defects. The French word "saine" is, we believe, similarly employed throughout the industry.

Our final thought is that, by international co-operation in the production of a foundry dictionary, each nation will enrich its knowledge of the mental approach to foundry problems exercised abroad. Unquestionably the final result will be a simplification in nomenclature as used for international expression of thought.

D

Correspondence

[We accept no responsibility for the statements made or the opinions expressed by our correspondents.]

Evaluation of Returned Scrap

To the Editor of THE FOUNDRY TRADE JOURNAL.

SIR,—The article on the above subject in your December 22 issue is useful as a small exercise in mathematics but, like all mathematical calculations, is correct only to the extent the premises are sound. An example of what the suggested formula leads to may be appreciated by assuming that one ton of borings is to be melted in an electric furnace. Taking the cost of borings as £2 per ton, and the cost of melting as £3 per ton, your contributor says, in effect, that if 25 per cent. of the metal is returned as scrap and added to a subsequent charge, the value of that scrap in the calculation of the cost of the subsequent charge is 25 per cent. of £5, or 25s. for the 5 cwts.

Efficient costing demands a substitution of Equation I in the article by the simpler and more correct process of debiting the 75 per cent. of sound castings first produced with the cost of melting the 100 per cent. of metal, and debiting the subsequent heat with the open-market scrap value of the 25 per cent. metal returned from the earlier heat. Returned metal possesses, normally, no advantage by having been melted previously, so why, as proposed, consider its value higher than that of ordinary scrap? In effect, the proposed mathematics would increase the value of the scrap each time the scrap is again melted, as Equation I is accumulative on repetition. A few calculations on the proposed basis would show that that portion of the returned scrap which had formed part of a good number of successive previous heats ultimately competed with precious metals in supposed value! The equation in question might, however, be added to the scrap without increasing the value of a charge.

Yours, etc.,

MATHEMAGICIAN.

December 24, 1938.

Birlec Furnaces

The success of the many types of mechanically-operated furnaces designed and produced by Birmingham Electric Furnaces, Limited, of Birlec Works, Tyburn Road, Erdington, Birmingham, with special reference to those with controlled atmospheres, has resulted in many requests being received for the supply of similar furnaces, gas-fired, for use under conditions where electrical energy is unduly expensive or even unobtainable, and where cheap gas is available. The advent of the radiant-tube gas-fired heating element has now made it possible to use gas as the heating medium for such furnaces, and consequently this company have, after careful consideration, decided to widen their field, and to undertake the manufacture of certain types of gas fired furnaces. In some circumstances a combination of electric and gas heating will be offered. Most of the gas heating will be by means of radiant-tube elements, the design and patent rights of an exceptionally efficient type being possessed by the company.

It is the belief of this company that whilst in certain cases gas firing can be used as an alternative to electric heat, in very many applications the electric method offers advantages unobtainable by combustion methods, and for this reason they have no intention of offering gas firing with all types of furnaces, but will restrict themselves to those types where, under certain economic conditions, they can recommend them with confidence.

CLYDE CRANE & ENGINEERING WORKS, LIMITED, Mossend, have had a record year. During the past three months, the number of cranes and winches produced was over 100. The products of the firm are in great demand at practically all Scottish docks and on liners. The number of employees is now 300, the largest ever employed at the works. The holiday period is to be of short duration, the resumption will take place in the middle of New Year's week.

Notes from the Branches

MIDDLESBROUGH AND NEWCASTLE JOINT VISIT TO DARLINGTON STEEL FOUNDRY

The steel foundry of Thomas Summerson & Sons, Limited, of Darlington, was visited on December 3 by about 120 members of the Middlesbrough and Newcastle-upon-Tyne Branches of the Institute of British Foundrymen. The party was received by Mr. T. H. Summerson, director of the company, and was conducted round the foundry by members of the steel foundry staff, under the direction of Mr. J. Hedley, steel foundry manager.

The foundry has a capacity of about 300 tons per month of steel castings of all classes and types up to 4 tons in weight. Jobbing work is moulded in one bay, and machine-moulding in adjacent bays, all served by adequate high-speed cranes. Steel production is by Stock converter and a Greaves Etchells electric furnace. These processes are controlled from the laboratory, which has recently been enlarged and equipped for the testing of moulding sands. This addition has proved of the utmost utility towards improving the quality of castings, and especially in the development of green-sand mixtures for the mass production of precision steel castings of intricate design.

The compressor house, equipped with four compressors, is capable of supplying 2,100 cub. ft. of air per min. at 90 lbs. per sq. in. pressure, which allows the four shot-blast chambers, the hammers, moulding machines, etc., to operate at their maximum efficiency, and without stoppage on account of a drop in the pressure.

The patternshop organisation is especially noteworthy for a simple card-index system of pattern storage, the cards bearing such details of heads, gates, etc., as will ensure successful manufacture of repeat orders.

Machine methods for producing moulds and cores are extensively employed in order to obtain accurate work, and also to reduce pattern distortion and destruction. Both of these features are recognised as being of the highest importance in the mass production of precision castings.

Inspection, testing and despatch of the finished castings are carried out in a separate shop, which provides excellent facilities for the inspection staff to function thoroughly and without interference. Probably 50 per cent. of the castings produced are jig-tested before despatch to ensure that they will drop into customers' machining jigs, and show adequate but minimum machining allowances without the necessity for marking-off. These methods of mass production offer undoubted advantages to the buyer, in that the black weight of the castings is low, marking-off costs are eliminated, and cutting times are reduced to a minimum.

The party was entertained by the firm to tea following the visit, when expressions of appreciation of what they had seen were made by Mr. A. Scholes, of Pattinson & Stead, and Mr. G. P. Kirk and Mr. G. Elston. The visit was organised by Mr. C. Lashley and Mr. Kirk, the honorary secretaries of the two Branches entertained.

THE SECOND ANNUAL dinner of the Planet Foundry Social Club, Audenshaw, was held on December 17 at Ashton-under-Lyne. Mr. F. Moffat presided over a company of 117, supported by Mr. Archibald (general manager), Mr. Campbell (works manager), Mr. Carlyle (commercial manager) and Mr. Craven (secretary). Mr. J. Shaw, managing director of the parent company, Allied Ironfounders, Limited, sent a message regretting his absence. Following an excellent dinner Mr. Archibald referred to the 50 years' service just completed by Mr. H. Gardner in the moulding department. Mr. Gardner was presented with a gold watch in recognition of his long service.

Random Shots

Some people—and not all of them misogynists—hold that women are entering into far too many of the activities hitherto reserved for men. Others (shame upon them) regret the inevitable dearth of really good stories resultant upon the presence of ladies. A few declare that the essential common interest which brings a certain group of men together is too freely diluted by bringing in the ladies; and one man has the boldness to admit that he is thereby precluded from flirting with the artistes! These are but a few of the reasons put forward whenever the question is raised as to whether or not a banquet is to retain its former character of being a stag party. Whatever the objections, they were obviously overruled when the arrangements were made for the annual dinner of the London Branch of the Institute of British Foundrymen, which this year, for the first time in its history, included ladies. There can be no shadow of doubt that the experiment was entirely successful. The gaiety of colour introduced by the ladies' dresses; the lightness of heart which comes with the dancing made possible by the presence of the ladies (and men who had never been known to dance before were seen joining in the carefree steps of the Lambeth Walk!); and the more frivolous turn of dinner conversations—all these are qualities of a "mixed affair" which are not to be sneezed at in these dark and menacing times. So, for an evening's entertainment, divorced from everyday cares of business, and dedicated to pleasure, gaiety and colour, let the London foundrymen thank their ladies! As Mr. Newman after the dinner very aptly put it: "A phantasy in many colours is better than a pure design in black and white.

* * *

If any man still has his grudge he can at least attend the dinners given by the Scottish and Sheffield branches, who are still to be numbered amongst the (shall we say?) unenlightened.

* * *

Members of the London Branch of the Institute of British Foundrymen and the London Section of the Institute of Metals were reminded by Mr. Barrington Hooper at their joint meeting in London this month that these annual meetings have been held without interruption over a period of 18 years. Further, he recalled that the very first meeting of the London Section of the Institute of Metals was actually the inaugural event in this series of joint meetings. "Marksman" wonders whether any two other societies can cap this record.

"MARKSMAN."

Catalogue Received

Annealing Ovens. A four-page leaflet, issued by Gibbons Bros., Limited, of Dibdale Works, Dudley, Worcester, illustrates and annotates two types of ovens for annealing malleable cast iron, special grey iron and steel castings. One is of the tunnel or continuous type, and five advantages are listed for it. The second one emphasises that the stacking of the pots is effected externally, so inducing better working conditions, but what should have been added is some reference to the very considerable saving in floor space. Another major advantage of this type of furnace is the orderliness in operation, as only relatively small quantities are introduced into and removed from the oven at regular intervals. The second type, which is also gas-fired, is a batch oven provided with modern handling arrangements. This leaflet is available to our readers on request to the Dudley Works, and it is certainly worth while to take advantage of this offer, as economic annealing is a factor of major importance.

Sand Research and Scrap Reduction

FALKIRK LECTURE BY MR. T. TYRIE

"A Talk on Sands" was the title of a lecture given to the Falkirk Section of the Institute of British Foundrymen last month by MR. T. TYRIE, B.Sc. (superintendent of the Scottish laboratories of the British Cast Iron Research Association). Mr. R. R. Shaw was in the chair.

The first part of the address dealt with the apparatus currently used—a subject which has been covered by several authors. His later remarks covered a series of extremely interesting researches directed towards the solution of foundry defects and are reported below *in extenso*.

New Sand Supplies

It is interesting to see how sand testing is applied to the evaluation of foundry sands. Attention will first be directed to a consideration of typical new sand supplies used for light castings. Table I gives in tabular form the properties of a number of sands, and the difference in working properties known to exist in practice is clearly brought out by the differences in the numerical values. The outstanding difference between the white and yellow rotten rock sands and the finer English sands is clearly brought out; the former, by reason of their higher clay content and coarser nature are in general much stronger and more open sands—decidedly useful in moderate quantity for re-bonding purposes, but hardly to be recommended from the point of view of permeability, since the difference in grading between the rock sands and the commonly used Erith, Pickering and Mansfield sands is so great that the latter sands pack in between the grains of the former, and instead of maintaining permeability the net result of too liberal a use of these rock sands is a lowering of the permeability.

TABLE I.—*Results of Physical Tests on Virgin Sands.*

Sand.	Moisture. Per cent.	Compression strength (A.F.A.). Lbs. per sq. in.		Permeability A.F.A. No.		Loss on ignition. Per cent.	Apparent density.
		Green.	Dried.	Green.	Dried.		
White Rock, source A	6.55–9.50	6.1–7.1	123.0–146.2	52–59	66–79	4.0	1.65–1.71
" " " B	5.70–9.80	7.8–10.8	83.1–157.7	24–98	25–104	3.7	1.68–1.85
Yellow Rock, source A	7.00–8.85	4.7–5.7	111.5–169.7	59–65	90–117	3.5	1.65–1.70
" " " B	6.40–8.95	5.9–7.5	88.1–120.5	81–118	102–175	1.5	1.70–1.77
" " " C	6.75–9.30	5.5–5.9	90.2–129.8	44–56	73–79	3.0	1.65–1.69
" " " D	7.00–9.70	5.1–7.9	50.2–89.7	30–39	31–44	2.1	1.54–1.69
Pickering	6.50	14.8	100.7	25	26	1.9	1.57
Erith	4.50–7.30	4.3–4.9	23.5–56.3	32–33	37–47	5.5	1.35–1.38
Wormit Red	7.05–10.05	1.4–1.6	31.4–51.3	54–65	63–73	0.5	1.57–1.65
Carlisle Red	7.00–9.50	3.8–4.1	40.6–84.9	28–31	35–41	1.5	1.57–1.65
Belfast Red	7.10–10.20	2.6–2.9	32.1–52.8	18–20	23–26	2.5	1.54–1.61
Mansfield Red ..	2.95–6.40	4.3–4.7	34.2–115.5	25–37	28–44	4.5	1.55–1.57
Heck Red	6.50–9.50	5.2–6.5	18.5–25.3	64–75	67–81	1.6	1.60–1.64

In this connection, attention should be directed to Wormit red sand which, in grading, falls just a little coarser than the English sands used in Falkirk and ought to be of value in maintaining permeability. It is felt that the greater use of a sand of this class would be definitely beneficial from this point of view. Whilst acknowledging the value of Erith, Mansfield and similar sands for the production of light castings, the continued use of such sands over long periods leads to a gradual closing up of the sand heaps, and, as previously indicated, the use of the rock sands for re-bonding, while accomplishing that part, still further aggravates the decrease in permeability; hence the necessity of frequently adding a sand of just coarser texture than the basic sand to counteract this natural closing up of the heaps. As a result of much experimental work, it would appear that Wormit sand functions very well in this capacity, and it is felt that its use in many cases would prove definitely beneficial.

Table II gives the mechanical grading of these new sands, and the difference in texture will be seen. From these figures it will also be appreciated how the addition of a coarse sand to a fine one will close up the mixture instead of increasing the permeability, as might be expected, unless the addition of coarse sand is such as to alter entirely the grading of the mixture.

Examples from Practice

A few examples may be considered, showing the value of sand examination and control in elucidating troubles and effecting improvements in existing practice. Mention was made earlier of the results which invariably accrue from the addition of a coarse sand to a fine one, and the first example has been chosen to illustrate this point. In Table III the top row of figures gives the physical properties of a facing sand used for an important class of flat plate work, and the only criticism which might be levelled at the sand is that the green strength is far in excess of requirements. This high strength was, of course, obtained at the cost of a very high addition of new sand in preparing the facing sand, and it was decided to reduce this until the minimum addition of new sand was being used commensurate with adequate strength properties as shown by sand tests, advantage being taken of the high bonding value of Scottish rock sand to accomplish this end. After a time, it was observed that whilst the strength values were steadily maintained at a desirable figure, the permeability was just as steadily falling, by reason of the fact that the rock sand was of an appreciably coarser texture than the floor sand which formed the basis of the mix, this being shown by the figures in the second row of Table III. The only way to remedy this was to add a sand just a degree coarser in grading than the basic sand, and on doing so the test figures shown as the final row in Table III are obtained. The strength figures are still ample for the class of work, and the permeability has been restored. The sand as now compounded contains 29 per cent. of new sand where formerly it contained 63 per cent., and the results obtained in the foundry are certainly as good, if not in some respects better.

TABLE II.—*Mechanical Grading of Virgin Sands.*

Sand.	Clay. Per cent.	Percentage retained on individual sieves.								
		20 mesh.	30 mesh.	40 mesh.	60 mesh.	80 mesh.	90 mesh.	100 mesh.	120 mesh.	< 120 mesh.
White Rock, source A ..	16.51	6.60	2.54	2.20	8.20	19.48	15.66	4.88	11.96	28.48
" " " B ..	23.95	—	10.30	—	51.54	—	24.98	—	1.74	11.44
Yellow Rock, source A ..	15.17	8.68	3.10	2.52	9.28	27.54	17.70	4.94	9.38	16.86
" " " B ..	16.48	7.50	7.70	13.48	24.40	10.62	4.50	0.66	7.02	24.12
" " " C ..	13.45	6.78	2.16	2.28	4.84	21.38	15.18	4.76	13.18	29.44
" " " D ..	13.80	—	2.60	—	5.18	—	2.34	—	25.30	64.58
Pickering	19.29	—	0.30	—	0.78	—	0.02	—	17.20	81.70
Erith	5.61	0.22	0.44	0.46	0.52	0.30	0.18	0.20	0.98	96.70
Wormit Red	5.47	0.80	0.24	1.36	1.11	13.54	11.06	1.84	14.80	45.26
Carlisle Red	14.55	0.90	1.18	1.40	2.38	2.06	2.02	0.98	5.62	83.46
Belfast Red	6.68	0.03	0.05	0.02	0.66	1.26	2.42	1.18	5.44	88.94
Mansfield Red	10.92	0.64	0.66	0.76	1.86	2.18	2.98	1.40	10.48	79.04
Heck Red	11.30	—	1.40	—	38.98	—	12.90	—	31.12	15.60

Table IV serves as an illustration of the difficulties which may arise from the lack of understanding of the properties required in a sand for particular types of moulding machines. Experience with a large variety of moulding machines has shown that each type has characteristics which must be recognised, and sand supplies must have properties suited to the machines, if the best results are to be obtained. In the present instance, the machine in question was the Sandslinger. This particular machine was installed in 1932, and the sand tests conducted at the request of the operator sent to supervise the installation and demonstrate its use are shown. In passing, it may be said that even at the outset the sand employed was not entirely satisfactory. The green compression strength is rather low, and the dried compression strength leaves much to be desired, being too low for safe working. However, in spite of this, the results obtained were considered satisfactory, and the machine was in daily use for a few years. The matter of sand reconditioning was left entirely to the judgment of the operator, and the normal procedure was to sprinkle a liberal amount of new sand over the heap at the end of each week, this being worked in whilst the machine was in operation at the beginning of the next week.

In course of time, troubles began to arise; moulds were not uniformly rammed, with the result that swelling on castings became common, and an extensive use of the vent wire became necessary to overcome defects due to blow-holes. Production dropped appreciably, as the amount of hand work on moulds increased, and the machine fell gradually into distaste with the operators. At this stage, the opportunity was given of making a study of the machine and the work produced on it, and on conducting sand tests results were obtained as shown in the lower row of figures in Table IV. It will be seen that the sand had altered considerably in texture during the period. The amount of fine-grade material had increased from 28 to 40 per cent., and this is reflected in the permeability. The strength values were up, which in the case of the dried strength was an improvement, but in the case of the green strength was definitely the cause of the non-uniformity in ramming. The extent to which silting up of the heap had proceeded will be apparent from the serious decrease which had taken place in permeability, and on taking steps to restore the heap to its former condition, the troubles were reduced to their former level, and ultimately largely eliminated.

Given sand suited to it, the Sandslinger will justify its existence in almost any foundry, and on a wide variety of work. The essential things to remember are: (1) It will not ram underneath projecting parts of a pattern nor under box

bars, which means in respect of the latter that bars should be reduced to a minimum or eliminated entirely and grids used for turning over the moulds; (2) it rams very hard, for which reason sand normally considered too weak for hand moulding is well suited for this machine; (3) in virtue of the hardness of the ramming, it is essential to ensure that the sand used has a fairly high permeability number if artificial venting is to be kept at a minimum.

TABLE III.—*Properties of Facing Sands.*

Sand.	Moisture. Per cent.	Compression strength (A.F.A.). Lbs. per sq. in.		Permeability A.F.A. No.		Loss on ignition. Per cent.	Gas evolved per cub. ft. of sand. Cub. ft.	Apparent density.
		Green.	Dried.	Green.	Dried.			
Old facing ..	7.00	12.0	85.4	21	23	10.5	53.1	1.50
New facing ..	5.93	7.3	110.0	16	19	6.1	62.0	1.57
With Wormit ..	6.50	5.7	74.6	29	33	6.3	61.2	1.50

Mechanical Grading.

Sand.	Clay. Per cent.	Percentage retained on individual sieves.				
		30 mesh.	60 mesh.	90 mesh.	120 mesh.	< 120 mesh.
Old facing	16.39	15.00	0.40	1.84	8.84	74.28
New facing	16.20	8.40	15.40	3.10	7.90	65.20
With Wormit ..	12.15	6.40	12.40	1.50	14.90	64.80

Enamelling Troubles

The periodic occurrence of troubles in an enamelling shop through blistering defects in pipes, which had to be lined inside with an enamel, brought out a further instance of the value of sand testing in tracing difficulties. In this particular case, the same moulder was always given the work of preparing pipes for enamel finish, and in general his products were fairly satisfactory. Occasionally, however, a bout of trouble would arise which could not be explained from the purely practical point of view. Every care was taken in the manufacture of these pipes, including the use of black-washed and dried cores, which was considered the utmost that could be done to ensure an inner surface free from sand holes and dirt, which undoubtedly formed the basis of the blistering experienced in enamelling, and, so far as visual examination showed, the pipes were as near to perfect as could be expected.

It so happened that in the course of a systematic examination of all sand heaps in this particular establishment, the sand used by this moulder had been tested some six months prior to the occurrence of a spell of enamelling difficulty, and the results then obtained are shown in Table V. Sand tests were conducted when the trouble began, and one cannot but be struck by the difference in properties. It will be seen from Table V that strength values have fallen off badly. Green compression strength is only half its former value and is much too low. Dried compression strength amounts to almost nil. Permeability figures are unaltered, but can be explained. Looking at the sieve test figures, it will be seen that the clay content has dropped, though scarcely as much as would account in itself for the great loss in strength suffered by the sand. The general grading of the sand, however, is much altered. The proportion of fines passing 120 mesh has increased from 28.7 per cent. to a value of 46.32 per cent. The amount passing 100 mesh but retained on 120 mesh has risen from 9.88 per cent. to 12.76 per cent., and the proportions of the coarser sand grains from 20 to 100 mesh are *pro rata* less to compensate for the increase in fines.

Obviously, this heap of sand has deteriorated badly, and the trouble experienced in the enamelling shop can be explained in terms of its physical condition. In a much coarser sand the amount of active clay bond shown here would be ample to cement the sand grains together and give a reasonable strength, but in the present case the fineness of the sand demands a higher content of plastic clay to coat effectively the individual sand grains. The net result is a sand of poor strength, more especially in the dried condition, and one which cannot resist the wash of metal in casting, giving rise to sand hole troubles and burning-in. Also, the excessive amount of fines is conducive to low refractoriness, which naturally leads to fritting of the sand grains, and enhances the burning-in of sand.

It may be felt that the consistency of the permeability results is somewhat anomalous in view of the increased proportion of fines, but a little thought will show that this is in no wise at variance with the other results and findings. The amount of available plastic clay bond is insufficient to cement the sand grains together, with the result that while the amount of fines is high, the fines and coarser sand grains are only loosely held together, if cemented at all, instead of forming a solid and compact mass; and the effective pore space is not appreciably diminished.

It is the custom in this foundry to use black-washed and dried cores for pipes which are to be enamelled inside, and under normal sand conditions this practice should produce a better skin on the interior of the pipe; but it is questionable if such procedure would be so satisfactory using sand of the properties here shown. The excessive weakness of the sand in the dried condition, together with the difference in expansion of the black-washed layer and the layer of sand immediately below, is almost certain to lead to spalling of the outer surface, and the consequent formation of sand or dirt holes. The sand was treated to restore it to something like its former value, and the trouble disappeared.

TABLE V.—*Deterioration of Properties of Pipe Sand which Led to Enamelling Difficulties.*

Sand.	Moisture. Per cent.	Compression strength (A.F.A.). Lbs. per sq. in.		Permeability A.F.A. No.		Loss on ignition. Per cent.	Apparent density.
		Green.	Dried.	Green.	Dried.		
Pipe sand, December, 1937 ..	8.43	3.8	36.1	39	41	6.2	1.56
Pipe sand, June, 1938 ..	8.60	1.9	2.4	39	41	7.0	1.52

Mechanical Grading.

Sand.	Clay. Per cent.	Percentage retained on individual sieves.								
		20 mesh.	30 mesh.	40 mesh.	60 mesh.	80 mesh.	90 mesh.	100 mesh.	120 mesh.	< 120 mesh.
Pipe sand, Dec., 1937 ..	13.56	6.20	2.10	2.04	9.64	19.64	16.94	4.86	9.88	28.70
Pipe sand, June, 1938..	10.80	2.92	1.36	1.58	6.90	11.26	14.60	2.30	12.76	46.32

TABLE IV.—*Properties of Sand used for Sandslinger, showing Deterioration between* 1932 *and* 1936.

Sand.	Moisture. Per cent.	Compression strength (A.F.A.). Lbs. per sq. in.		Permeability A.F.A. No.		Loss on ignition. Per cent.	Gas evolved per cub. ft. of sand. Cub. ft.	Apparent density.
		Green.	Dried.	Green.	Dried.			
1932	7.60	5.20	26.4	43	46	5.5	45.1	1.57
1936	7.23	8.00	87.0	16	20	5.9	47.6	1.63

Mechanical Grading.

Sand.	Clay. Per cent.	Percentage retained on individual sieves.								
		20 mesh.	30 mesh.	40 mesh.	60 mesh.	80 mesh.	90 mesh.	100 mesh.	120 mesh.	< 120 mesh.
1932	17.11	4.30	2.46	2.86	14.46	19.36	14.06	1.72	12.60	28.18
1936	21.66	1.98	1.56	1.52	7.04	17.90	14.02	2.94	12.68	40.36

Sand for Bath Moulding

Those familiar with the moulding of baths and similar articles will realise that a considerable amount of mould dressing is applied to the mould surfaces and well rubbed in. An interesting example of the effect which the accumulation of blacking or similar substances has in reducing the strength of a sand heap is illustrated by Table VI. Some trouble in obtaining sound castings led to an examination of the sand condition, and the surprisingly low dried strength of 18.5 lbs. per sq. in. was obtained, together with an exceedingly low permeability figure. The gas evolution figure was not unduly high, but the loss on ignition is excessive. Taken in conjunction, these figures indicate an excessive amount of blacking or carbonaceous mixture in the sand, and it is readily understood why the dried compression strength is low under these conditions, while the green strength is quite satisfactory. The sand grains are carrying a heavy coating of graphite, which has an appreciable amount of stickiness when wet, and does not interfere with the green bond. In fact, the fineness of the material rather enhances the green strength, but in the dry condition bond amounts to nil and militates against the effectiveness of the clay in cementing the sand grains together; hence the poor dried strength. The extreme fineness of the carbonaceous dressings reduces the permeability with the result shown.

On treating this sand with a suitable mixture of new sands, the condition was improved to

give the properties shown in the lower row of figures in Table VI and considerably improved results were obtained in practice. It may not be appreciated, but the amount of blacking-plumbago mixture used on a single bath mould in some foundries amounts to as much as 7 lbs., actually rubbed in, and when it is realised that this is going on daily for years the accumulative effect of this is bound to react on the quality of the sand, if effective measures are not taken to dilute it by suitable addition of new sand.

TABLE VI.—*Properties of Original and Reconditioned Sand.*

Sand.	Moisture. Per cent.	Compression strength (A.F.A.). Lbs. per sq. in.		Permeability A.F.A. No.		Loss on ignition. Per cent.	Gas evolved per cub. ft. of sand. Cub. ft.	Apparent density.
		Green.	Dried.	Green.	Dried.			
Original	8.00	5.7	18.5	10	11	13.0	62.2	1.64
Reconditioned ..	8.50	5.7	84.4	32	38	7.5	53.6	1.68

Mechanical Grading.

Sand.	Clay. Per cent.	Percentage retained on individual sieves.								
		20 mesh.	30 mesh.	40 mesh.	60 mesh.	80 mesh.	90 mesh.	100 mesh.	120 mesh.	< 120 mesh.
Original ..	20.10	3.32	1.62	1.60	7.04	15.82	11.68	3.04	13.60	42.28
Reconditioned	15.57	1.28	2.62	1.92	11.36	19.22	15.12	3.50	14.00	30.98

Sand and Venting

On this same subject, attention was directed to the great amount of artificial venting which is normally carried out in making a bath mould, and experiments were instituted to find out how far this might be reduced by the use of rather more open sands, while still maintaining the high class of casting required for enamelling. Table VII shows the sand test figures covering the experimental stages, the first row showing the original bath sand, and the second the sand prepared from this by the addition of suitable new sands. It will be seen that the strength figures were maintained virtually the same, though the strength was obtained at a rather lower moisture content with the new sand mix.

The permeability, on the other hand, was increased by over 200 per cent., and the effect of the new sand addition in diluting the carbon content of the heap is shown by the reduction of the loss on ignition figure. For the first trial, the amount of venting in both cope and drag was reduced by half, and on casting, the operation was completed without the slightest sign of bubbling. The same sand was used the following day for another mould, and on this occasion the amount of artificial venting was reduced to half that of the previous day. Again the cast was perfectly quiet and the casting all that could be desired. This was continued each day until the artificial venting was eliminated entirely, and in every case the cast was perfectly quiet, and the bath a sound enamellable casting.

Sand tests conducted at the end of the week showed the figures given in the final row, and while there is a drop in strength and a lowering of the permeability, which is to be expected, it is possible that these reductions are partly due to the fact that the moisture content of the sand as tested finally is lower than originally, and the loss in strength and reduction in permeability were not really as great as the tests appear to indicate. The increase in the loss on ignition figure should be noted, and this is definitely due to the increase in the amount of blacking-plumbago mixture in the sand again, as the tests were conducted under normal moulding practice in so far as the dressing of the moulds was concerned.

The experiment was interesting as it quite definitely established the fact that, by suitable choice of sand conditions, it is possible to produce a bath having the quality of skin desired for enamelling, with a more open class of sand than is normally used, thereby eliminating entirely, or at least appreciably reducing, the amount of artificial venting generally required to ensure a satisfactory casting.

TABLE VII.—*Physical Properties of Sands for Bath Moulding.*

Sand.	Moisture. Per cent.	Compression strength (A.F.A.). Lbs. per sq. in.		Permeability A.F.A. No.		Loss on ignition. Per cent.	Apparent density.
		Green.	Dried.	Green.	Dried.		
Original bath sand	9.50	5.7	59.9	17	21	9.0	1.67
New bath sand	8.40	6.7	59.1	42	51	5.5	1.71
After 6 days' work	7.50	5.7	51.3	36	41	6.0	1.70

Synthetic Sands

No claim is made to a very extensive experience with synthetic sands, but their use has been developed to a great extent by several firms in Britain, and to a still greater extent in America, where the lack of suitable and unlimited supplies of sand has forced the foundry industry to develop the synthetic sand. It will be understood that by "synthetic sand" is meant a moulding sand composed of a silica sand suitably bonded by the addition of some form of clay, generally china clay or one or other of the highly colloidal clays sold under the names of Colbond and bentonite. China clay is quite effective, but its bonding power is small in comparison with the colloidal clays, and for equal bond it may be taken that some 18 per cent. of china clay will be required to give the same green strength as may be obtained with 6 per cent of Colbond or 3 to 4 per cent. of bentonite. The latter is more colloidal than Colbond, and less is required to develop a satisfactory strength, but the Colbond has an advantage in that it has a somewhat higher fusing temperature and is accordingly more refractory. For light casting work, however, where casting temperatures are not excessively high, bentonite is highly satisfactory, and considerable amounts of it are in use in the preparation of synthetic sands and for rebonding sand heaps normally made up from natural sands.

One application of synthetic sand in light castings production which will be of interest is in the manufacture of cast-iron baths. The figures given in Table VIII are characteristic of the properties of a synthetic sand for this particular application. The outstanding differences between this and the properties of a normal bath sand as used in the Falkirk district will be evident. The much lower moisture content of the synthetic sand is one difference. The strength values are similar, but the permeability figures are different. This is largely due to the fact that the synthetic sand is composed of sand which is largely of uniform grade. It is not appreciably coarser in general texture, but it has not the coarse and fine sand grains found together in the natural sand, where the fine ones pack in between the interstices formed between the coarser, thereby reducing the effective pore space. A glance at the mechanical grading figures will show this characteristic.

Patching Difficulties

The extremely low moisture figures at which synthetic sands operate is an advantage in one respect, namely, that the amount of steam likely to be formed on casting is appreciably reduced, but the lowness of the water content combined with the high permeability contributes to a marked tendency to rapid drying out, with the result that these sands will not retain their workability when left exposed on the foundry floor as do the naturally-bonded sands. Another important difference between the synthetic and the naturally-bonded sands is that the former are very difficult to patch up should the mould suffer a tear in withdrawing the pattern, and in this operation to swab the mould edges as is commonly done in ordinary sand moulds is fatal. It is generally found more speedy and economic to knock out a mould and make a new one than to attempt patching to any degree.

The high permeability generally permits of moulding without the necessity of making artificial vents, but if too high it may introduce troubles which are equally bad as results from lack of permeability in the naturally-bonded sands. By reason of the high permeability, these sands have also a very high heat-conductivity value, with the result that the depth of penetration of heat on casting is appreciably more than in the case of the natural sands. This means

(*Concluded on page* 482.)

TABLE VIII.—*Properties of Synthetic and Ordinary Bath Sands.*

Sand.	Moisture. Per cent.	Compression strength (A.F.A.). Lbs. per sq. in.		Permeability A.F.A. No.		Loss on ignition. Per cent.	Gas evolved per cub. ft. of sand. Cub. ft.	Apparent density.
		Green.	Dried.	Green.	Dried.			
Synthetic bath sand	5.00	6.0	22.4	116	120	1.50	28.0	1.60
Ordinary bath sand	8.45	5.4	29.2	18	19	8.00	47.6	1.60

Mechanical Grading.

Sand.	Clay. Per cent.	Percentage retained on individual sieves.								
		20 mesh.	30 mesh.	40 mesh.	60 mesh.	80 mesh.	90 mesh.	100 mesh.	120 mesh.	< 120 mesh.
Synthetic bath sand	13.10	1.30	0.10	1.90	20.70	26.00	15.80	2.60	13.20	18.40
Ordinary bath sand	18.46	9.40	2.70	2.32	7.68	21.90	11.22	1.98	10.90	31.90

British Cast Iron Research Association

ANNUAL GENERAL MEETING

The annual general meeting of the British Cast Iron Research Association, held at the Dorchester Hotel, London, W.1, on December 15, took place immediately after the annual luncheon, a full report of which, together with extracts from the Annual Report, appeared in the JOURNAL last week. Dr. Harold Hartley (Chairman of Council) presided at the meeting.

The minutes of the preceding annual general meeting, held on November 4, 1937, were taken as read, and were confirmed and signed.

Adoption of Report and Accounts

The CHAIRMAN, proposing the adoption of the Council's report and the audited accounts of the Association for the year ended June 30, 1938, said that the total balance shown by the accounts was about equivalent to the amount required to keep the Association going for two months. Shortly the Council would know what further assistance the Association could expect from the Department of Scientific and Industrial Research; but it was important that the Association should secure added industrial assistance, and it would probably have to increase the sum of money subscribed before it could obtain a Government grant.

The resolution for the adoption of the report and accounts was seconded by Mr. P. A. Abernethy, and was carried.

Lord Dudley Re-elected President

On the motion of Mr. H. B. Weeks, seconded by Mr. J. E. Hurst, the meeting unanimously re-elected the Rt. Hon. the Earl of Dudley, M.C., as President. The Director of the Association was asked to convey to the Earl of Dudley the gratitude of the members for his past services.

On the motion of Mr. J. B. Allan, seconded by Mr. V. C. Faulkner, the meeting unanimously re-elected Lord Austin of Longbridge and Prof. Emeritus T. Turner, M.Sc., A.R.S.M., F.I.C., Vice-Presidents of the Association.

Mr. Weeks Elected to Honorary Membership

The CHAIRMAN proposed the election of Mr. H. B. Weeks, F.I.C., as an honorary member of the Association. He recalled that Mr. Weeks was chairman of Council from the inception of the Association until January, 1937, and had served the Association very well indeed during a period in which it was suffering from growing pains! No trouble had been too great for Mr. Weeks if he were convinced that, by taking that trouble, he could assist the development and continued success of the Association. The least that the members could do was to ask him to continue to work for them, and with them, in the capacity of honorary member, and to assure him that they would be proud to number him among the Association's honorary members.

MR. P. A. ABERNETHY, seconding, said that as a member of the Council and of various committees he had noted that Mr. Weeks had devoted his heart and soul to the work of the Association, and it had been refreshing to come into contact with him. His long experience in industry had enabled him to help the Association out of its difficulties.

The resolution was carried with enthusiasm.

MR. H. B. WEEKS, F.I.C., said he could not express adequately his appreciation of the honour conferred upon him. He had always regarded his work on behalf of the Association as his first duty, and he was proud of the fact that, during the 16 years in which he was chairman of Council, he had never missed a Council meeting.

On the motion of Mr. C. C. Booth, J.P., seconded by Mr. A. Hoare, the following Members of Council, who retired automatically under Article 27, were re-elected:—Dr. Harold Hartley, Mr. J. B. Allan, M.A., Dr. S. F. Barclay, Mr. C. W. Bigg, Mr. V. C. Faulkner, Prof. D. Hanson, D.Sc., Mr. J. Hepworth, M.P., Mr. P. Pritchard and Mr. J. Smith.

On the proposal of Mr. A. Phillips, seconded by Mr. Somers Brown, the meeting re-elected Messrs. Poppleton and Appleby Auditors for the ensuing year.

Vote of Thanks to Council

MR. A. HOARE, proposing a vote of thanks to the Council for its work during the past year, first expressed his great pleasure, as representing a firm isolated from the mainland (on the Isle of Wight), that Mr. Weeks had been elected an honorary member. For the consideration of the Council, Mr. Hoare suggested that the practice of holding regional meetings should be revived. Perhaps the regional meetings which it had been the practice to arrange in the past had been discontinued because they were not largely attended, or because of the expense involved; but such meetings were very helpful to those who were unable to make long journeys, even if they were held only once or twice a year. It gave them the opportunity of discussing some of the results of the research which had been going on in the centre of the country.

MR. R. C. TUCKER seconded. In his capacity as a Member of Council, he singled out Mr. Pearce, the Director, as having done the lion's share of the work of the Association. All who had had any dealings with the Association, he said, as inquirers or in other ways, appreciated the amount of enthusiasm and energy that Mr. Pearce devoted to the work, and much of the hard work and enthusiasm of Members of the Council must be due in some measure to the efforts of Mr. Pearce, who applied the detonation. Not only did the members thank the Council for having managed affairs so splendidly, but hoped that it would be successful in its efforts to persuade further members of the industry to support the work.

The vote of thanks was carried with acclamation.

Vote of Thanks to Director and Staff

The CHAIRMAN expressed the warm thanks of the members of the Association to Mr. Pearce and his staff for their continued efforts. Although he (the Chairman) was in fairly close touch with the work of the Association, he had not appreciated until the recent visit of the Grants Committee what a very large amount of work was being done; and it was impossible for anyone to appreciate it until the opportunity to visit the laboratories was presented. The Association could not have achieved the success it had done had it not been served by an active and progressive Director and an intelligent and loyal staff. In addition to their original research and development work, they were dealing with the day-to-day problems of the industry. The representatives of the D.S.I.R. had been extremely impressed by what they had seen, and there was no doubt that the efforts of Mr. Pearce had done a great deal to ensure the sympathy of the Department.

MR. J. E. HURST (Chairman of the Research Committee), seconding, agreed that the demonstration to representatives of the D.S.I.R. was truly magnificent. It was impossible to select any one section of the Association's work for special praise, because the work in every department was extremely good, and was recognised on all sides as being of first-rate importance.

The vote of thanks was carried with enthusiasm.

MR. PEARCE, having expressed appreciation on behalf of his staff and himself, said that research was a heart-breaking job. Those who were prosecuting research never knew what the results would be; they wondered from day to day whether a thing would turn out right, and often they found that it did not. That was why he had special sympathy for those who, for reasons understood only by themselves, devoted their energies and careers to research. They had various difficulties, apart from the fact that very seldom could they afford to buy the equipment they would like to have in order to do the job properly. The staff of the Association were distracted by industrial noises around them in their present laboratories, and he looked forward to being able to provide better housing and equipment, and a superannuation fund. Sooner or later such things must be provided if the Association were to ensure the loyal service and contentment of the staff. He would be very happy indeed to convey the good wishes of the members to the staff, and would do his best to make it possible for them to work in the way they would wish in the future.

The Association's immediate objective, he added, was an income of about £25,000 a year, and the ultimate objective was about £40,000 a year. With the latter figure, he believed it could really serve the industry in the way it deserved and needed to be served, and if it could secure that income he would be perfectly satisfied.

Finally, on the motion of MR. S. H. RUSSELL, seconded by MR. J. E. HURST, the meeting expressed thanks to Dr. Hartley for having presided, and for the great help he had rendered the Association during many years.

Sand Research and Scrap Reduction

(*Concluded from page* 481.)

that a greater volume of sand becomes heated as a result of casting, and while the moisture content is much lower, and proportionately the volume of steam generated per volume of sand heated consequently lower, the fact that a greater volume of sand is heated means that the amount of steam generated may not be so much less than with the naturally-bonded sand after all. The effect of this is that there is a tendency for a large volume of steam to be generated just at the instant of casting, and while this would no doubt pass out of the mould quickly and give no trouble with moderate sectioned castings in which metal remains molten for a small interval of time, with the thinnest of casting sections, which solidify almost instantaneously, the metal is set before the steam has had time to clear away, and castings which are not completely run frequently result.

Personal experience with these sands also leads to the belief that there is a greater element of frictional resistance to the flow of molten metal over them than exists with the naturally-bonded sands, which leads to misruns and to castings which exhibit what is locally described as "rat tails." It has been found that, for satisfactory running, a moderate proportion of coal-dust or blacking must be incorporated in the sand mixture. The presence of either of these, especially the former, appears to reduce this frictional resistance and leads to better casting qualities; but as to the mechanism of this effect, no definite opinion can be expressed.

No doubt, there is a field for synthetic sands, but it cannot be said that they are ever likely to replace the naturally-bonded sands in this country, where the supply of good-quality moulding sands is almost unlimited. It cannot be too strongly emphasised to anyone attempting the use of synthetic sand for the first time that a moulding technique must be developed which is different from that employed in the use of the common moulding sands, and can only be acquired by patience and practice.

A discussion followed at the end of Mr. Tyrie's address, when comments were made by Mr. N. A. W. Erskine, Mr. J. S. Kidd, Mr. Montgomerie (Mr. Tyrie's assistant), Mr. J. A. Donaldson, Mr. Hughes (Grangemouth Iron Foundry), and Mr. R. R. Shaw. The closing votes of thanks were proposed by Mr. J. A. Donaldson.

High-Duty Cast Irons for General Engineering Purposes

FIRST REPORT OF RESEARCH COMMITTEE OF THE INSTITUTION OF MECHANICAL ENGINEERS

Prepared for the Committee by the Reporter, Mr. J. G. Pearce, M.Sc., M.I.Mech.E.

(*Continued from page* 462.)

PROPERTIES OF CAST IRON

The foregoing discussion has had reference mainly to tensile strength. Brief reference may be made to this and other properties which in cast iron are largely conditioned by the distribution, size and form of the graphite. The graphite flakes in cast iron may be regarded as discontinuities which give rise to stress concentrations. The material when loaded is therefore subjected to stress which varies from point to point according to the disposition of neighbouring graphite. Cast iron has therefore no elastic limit of the type ordinarily met with, the stress-strain diagram in tension or bending being a continuous curve, although in high-duty irons the early portion of such a curve taken at the lower loads tends to approach a straight line. Considerations of this sort also explain other properties of cast iron.

Hardness and Machinability

The Brinell hardness number is usually taken in accordance with British Standard Specification No. 240, 1926, at the standard 3,000-kg. load applied through a 10-mm. ball for 30 secs. For exceptionally hard surfaces the diamond hardness may be taken, or a rebound type of instrument used. Considerable experience has shown that there is no general relation between hardness and machinability or between hardness and wear. For example, the relatively low hardness values of austenitic iron, compared with pearlitic iron, offer no clue to the wearing properties of such irons. In irons of similar structures, however, as when pearlitic grey irons are compared among themselves, increased hardness generally implies higher mechanical properties and wear resistance.

As in all cast alloys, cast irons tend to be more open in structure and hence softer in the middle of thick sections than at the edge, and softer in thick than in thin sections. In cast irons this effect is emphasised by the tendency in thicker sections for flake graphite to thicken. Much of the work done in developing irons of high strength has aimed at minimising this sensitivity to wall thickness, that is, at producing uniform material irrespective of section.

The following figures may be expected for Brinell hardness numbers:—

	Brinell hardness No.
Very soft ferritic castings and completely annealed blackheart malleable cast iron	110— 140
Austenitic irons	140— 160*
Soft grey iron	140— 180
Pearlitic iron	160— 220
Pearlitic alloy iron of low alloy content	200— 250
Sorbitic irons	260— 350
Martensitic irons	350— 450
White iron, unalloyed (according to carbon content)	280— 500
Alloy white iron	450— 550
Martensitic white iron	550— 700
Nitrided iron (surface only) ..	900—1,000

* May be increased to 220 by raising the chromium content.

These numerals represent Brinell hardness numbers taken under the conditions of British Standard Specification No. 240, 1926, using a ratio $P/D^2 = 30$, except in the case of the nitrided iron which is usually tested with a diamond indenter machine. Machinability is to-day much less clearly definable than it was, but ordinary machining of cast iron is governed by the hardness and toughness of the matrix, the extent and distribution of hard constituents such as phosphide and carbide, and the extent and distribution of the graphite. The production of harder and tougher irons must be expected to result in lower machining speeds.

Tensile Strength

Tensile strength is a standard test for cast iron, which, however, ordinarily breaks under tension with very little elongation or reduction of area. Axial loading is very desirable in testing, as the imposition of a bending stress in addition causes premature failure. Malleable cast irons have appreciable elongation, from 5 to 25 per cent. according to treatment and composition. Tensile strength, like all other static properties, transverse strength, torsion, compression, increases as the size of the bar tested falls, as long as the metal remains grey. Tensile strength of cast irons increases slightly with temperature up to about 450 deg. C., when it begins to decline.

Transverse Strength and Deflection

Transverse strength is a standard test for cast iron, yielding the breaking load and deflection at fracture. The load is readily converted by the usual beam formula into a rupture stress, a procedure which is desirable because this necessitates measurement of the bar size (not to be taken as standard) and because there is a broad relation between tensile and transverse strength. In British Standard Specification No. 786 it will be noted that for a given bar the latter is about 11 tons per sq. in. greater than the former. The relation between irons of different qualities, however, is not constant.

The deflection under transverse loading is used as an index of ductility or toughness instead of elongation in tension; it increases with strength or with ductility. This deflection is made up of two components, the part remaining on removal of the load, called plastic deflection or permanent set, and the part recovered on removal of the load, called elastic deflection, the two making the normal total deflection. The elastic deflection curve with load approximates to a straight line. The permanent set shows very marked variations from iron to iron. Brittle irons have low set, and tough irons a high set. Such irons show a marked difference in shock strength. Deflection increases, for the same irons tested in bars of varying diameter at the same span, as the diameter of bar tested falls.

Elastic Modulus

Grey cast iron has a small plastic deformation at low loads and therefore has no true elastic limit or yield point. The usual methods of determining the elastic modulus are therefore not applicable, and there are various objections to other methods. In the tests given in Parts II and III, figures for the elastic modulus E are calculated on the beam formula, using for D the figure for the elastic deflection referred to above. The value for the elastic modulus of grey iron varies from 9×10^6 to 20×10^6 lbs. per sq. in., but for special irons values of 30×10^6 lbs. per sq. in. have been reached (Tables XXI and XXII).

Malleable cast iron has a definite yield, and the modulus is 23×10^6 to 25×10^6 lbs. per sq. in. White cast irons as a rule give erratic test figures on account of their brittleness, but frequently give strength figures exceeding those of the same iron in the grey state. The elastic modulus of white irons may reach 25×10^6 to 27×10^6 lbs. per sq. in.

Impact Strength

No standard test exists, although many empirical forms are in use. Standard Izod tests, on account of the small section and the notch, give very low results on ordinary cast iron, about 0.5 to 1.5 ft.-lbs., and do not differentiate adequately between different irons. This led to the use of the Stanton-type repeated-impact test using a rounded notch. This test, when using a small drop, or a small weight and drop, approximates to a fatigue test and considerable time is required. At a larger drop, or a larger weight and drop, the test approximates to the single-blow test, failure taking place after a few blows. Hence the standard weight and drop chosen (energy input, 0.48 ft.-lb.) are on the knee of the curve connecting energy of blow and number of blows to cause failure, where a small change in the metal, graphite distribution, etc., makes a pronounced difference to the result. Repeated impact figures are therefore apt to vary considerably for the same material, but the test does succeed in discriminating more sensitively between different materials than the tensile or transverse test. More recently, the standard Izod machine has been used with a special vice, using a 0.798-in. unnotched round bar in a single-blow test. Some results are given in Part II of the Report. The use of this machine has been rendered necessary in part by the length of time absorbed in repeated impact tests. In some results recorded, the bar was unbroken after a week under test.

Fatigue Strength

The fatigue strength of cast iron has been tested mainly in alternating bending and in alternating torsion. Under these conditions the endurance ratio of fatigue to tensile strength is rather higher than with most wrought materials. Generally, the more cast iron approximates to steel the more the endurance ratio approximates to that of steel. The fatigue limits for cast iron vary from ± 5 to ± 20 tons per sq. in. In exceptional cases an endurance ratio of unity has been recorded in reversed bending and closely approached in reversed shear.*

Cast iron is not very sensitive to stress-raisers, i.e., notches, holes, re-entrant angles and section changes in design, screw threads, oilways, etc., and this has been attributed to the fact that it is already notched by graphite flakes.

Damping Capacity

Cast iron has marked capacity for dissipating vibrational energy, as would be expected from its low notch-sensitivity. One of the reasons for its use in crankshafts is its capacity to absorb stresses which may be superimposed in ordinary working and which might otherwise build up to a dangerous condition.

Wear Resistance

Cast iron, grey or white, is universally used for its resistance to wear.* For mutual wear between engine parts pearlitic irons with medium-sized, evenly distributed graphite flakes are used, and, where otherwise acceptable, small dispersed areas of phosphide or carbide will improve wear resistance. Austenitic and white irons are used for their good resistance to wear.

* Gough, H. J., and Pollard, H. V., "The Strength of Materials under Combined Alternating Stresses". Proceedings of the Institution of Mechanical Engineers, 1935, vol. 131, p. 3.

* Pearce, J. G., I. Mech. E. General Discussion on Lubrication, 1937, vol. 1, p. 546.

Physical Properties

The thermal expansion of grey pearlitic irons does not vary much with composition, and is about 1.4×10^{-5} taken over the temperature range from 20 deg. C. to the critical temperature of the pearlite change referred to above. There is, however, an inflexion at a temperature usually between 200 and 300 deg. C., the Curie point or carbide change, below which the coefficient of expansion is close to 1.1×10^{-5}. Thermal conductivity varies between 0.11 and 0.14 C.G.S. unit and depends on composition and structure. Ferrite, pearlite, austenite and cementite have conductivity diminishing in the order given, an austenitic iron having a conductivity of about 0.07 unit. The electrical resistance of grey cast iron is about 60 to 100 microhms per centimetre cube, and that of austenitic irons about 150. The magnetic permeability of grey cast iron is about 240, and of austenitic irons about 1.03, these normally being virtually non-magnetic.

Corrosion Resistance

Corrosion resistance, like wear and heat resistance, are not intrinsic properties of the material, and hence can only be considered in relation to the service conditions on which they depend. Cast irons do not differ very markedly from other unalloyed ferrous materials in their resistance to mild corrosive agents, although they are at least as good as, where they are not better than, materials not specifically made as corrosion-resisting. For many types of attack the casting skin is more resistant than a machined surface. In engineering irons, sound, dense castings are more important than minor changes of composition in resisting corrosion.

High-silicon (15 per cent. silicon) irons have long been valued for their use in chemical plant, being perhaps the most acid-resistant ferrous material made. High-chromium irons (10 per cent. chromium) possess a valuable combination of high resistance to heat, corrosion and erosion, especially against sulphurous gases.

The austenitic irons such as "Ni-resist" and "Nicrosilal" are useful against corrosion, being 3 to 600 times as resistant as pearlitic iron, according to the medium, and are used also where service involves both corrosion and erosion. Their good mechanical properties encourage their use.

Heat Resistance

Ordinary cast irons are widely used where resistance to heat is required, but under severe conditions tend not only to scale, like most ferrous materials, but also to increase in volume, or grow. Growth is due to internal carbide breakdown, followed by internal oxidation, oxidising gases penetrating the graphite cavities and causing the formation of oxide greater in volume than the metal oxidised. The stress thus set up ultimately relieves itself in minute cracking, leading to the well-known "crazing" or "crocodile marking" on the working faces of ingot moulds and other castings.

Where machinability is not essential and brittleness not a handicap, white cast iron, which is free from graphite, is useful. Chromium renders the material more resistant and in the extreme case of 30 per cent. chromium iron, produces a tough, strong machinable metal, resistant to growth and scale. Test results of irons of this type are reported in Tables XXI and XXII.

For machinable grey irons subjected to heat a low silicon content and a fine close-grained structure are recommended, so long as the temperature does not exceed the critical point at 700 to 750 deg. C. Irons of the "Silal" type containing 5 to 6 per cent. silicon have good resistance to scaling and growth, but are rather brittle. They are ferritic, and hence offer no carbide to break down under heat, and have very fine graphite, offering least chance of ingress of oxidising gases. The silicon raises the critical point to about 900 deg. C., up to which they

(*Continued on page* 492.)

Extensions to the Stanton Laboratory

When the new laboratory at the Stanton Ironworks, under the control of Mr. W. Woodhouse, was opened in 1928, it was thought that the accommodation provided would be sufficient for a long time. Now, for the second time in ten years, further extensions have been made. The opening of new production plants, the use of new processes, and the company's policy of continuously striving to improve its products, have considerably extended the activities of the laboratory, and the latest extensions have been designed to enable work to be segregated into separate rooms. The new facilities will allow of greater concentration, efficiency and speed in giving results of investigations.

THE LABORATORY OF THE STANTON IRONWORKS COMPANY, LIMITED, NEAR NOTTINGHAM, EXTENSIONS TO WHICH HAVE NEWLY BEEN MADE.

Much more water analysis is now undertaken, partly on account of large water-conditioning plants at the works, and also because of the service to customers in testing water supplies in order to be able to quote for suitable pipe coating, and this is now carried out in a room solely devoted to this work.

Another section is used for the testing of oils and sand. For the latter a small August Simpson mill is installed, and also apparatus for finding the permeability, compression and tensile strength of oil sand, green sand and loam. In addition there are sieves and elutriators for testing the fineness and composition of sand and a mechanical sieve shaker to facilitate these tests.

In view of the increasingly large number of orders for pipes with Stanton-Wilson and Stanton screw-gland joints, the company has installed machinery and apparatus for the testing of the rubber rings used in these joints, and a room has been equipped for this work alone. Microscopical research has always been to the fore in the laboratory work, and to facilitate this a new Leitz "Panphot" photomicrographic outfit has been installed. This work has always been kept apart, and the new outfit, together with all polishing apparatus, etching reagents, negative and sample cabinets, has been transferred to a room in the new extension.

ONE OF THE ROOMS IN THE EXTENSION. A POLISHING MACHINE IS ON THE LEFT, THE "PANPHOT" OUTFIT IN THE CENTRE, AND NEXT TO IT IS AN ULTRA-VIOLET LAMP EQUIPMENT.

Of the two other rooms, one is equipped with shelves and racks for the storage of samples for later reference if necessary. Accelerated and progressive experiments on the action of effluents, trade waste, etc., and on concrete and iron pipes are also made in this room. In addition to this work, experimental research is carried out on soil corrosion problems.

Apprentices' Patternmaking Work

SOME ASPECTS OF SHEFFIELD COMPETITION

An account of the Apprentice Patternmakers' Competition, held in Sheffield last May, was given by the judges and others at a recent meeting of the Sheffield Branch of the Institute of British Foundrymen.

MR. J. B. ALLAN, who presided, said the competition was held for the sole purpose of encouraging craftsmanship among the younger generation, and it had been an undoubted success. It aroused considerable interest, and he thought it would create more discussion in the future as to whether it was beneficial and met the case it was intended. The advisability of such a competition or other methods of encouraging craftsmanship either in moulders or in patternmakers had been questioned. To his mind, if one result was to get young men to take an interest in the job, apart from their daily work, because of craftsmanship itself, they would have achieved a very great deal. There was another object, although it came to the same thing in the end; they were anxious to increase the membership of the Institute, and particularly of the Branch, and he thought the competition should encourage that. By increasing the strength of the Branch, they increased its capability of helping the profession.

Mr. Allan handed diplomas to the winners of the competition, as follow:—(1) W. Swift (19 years, 5 months); (2) D. Williams (17 years, 5 months); (3) H. Roberts (16 years, 4 months), the youngest of all the competitors.

How the Competition was Organised

MR. BROWN explained that the Competition Sub-Committee had first to guess how many people would enter the competition. Actually, they received 37 entries—20 from Sheffield, seven from Chapeltown, three from Doncaster, and seven from Chesterfield. The competition was divided into two classes, for those under 18 years and those over 18 years. For the juniors there were 12 entries, and 18 entries in the senior class, and they were classified as follow:—Eight "steel," two "manganese steel," 26 "iron and steel," and one "brass." Mr. G. Offiler had volunteered to search for a pattern which could be made in several ways. It was also limited to the timber factor for making the pattern, and limited to the construction of the pattern, because it was agreed quite early they could not have a pattern which necessitated glue being used. The pattern had to be designed so that it could be made in reasonable time by the younger entrants. He thought Mr. Offiler in the end did exceedingly well, because a large number of people finished their patterns in the time allowed. To prevent any leakage of inside information, the final drawing for the pattern was not made until the day before the test. Two patternshops were needed to run the competition adequately, and it was arranged that no competitor worked in his own shop. The English Steel Corporation and Hadfields, Limited, were good enough to offer the use of their shops. The stewards at the English Steel Corporation's works were Mr. J. Roxburgh and Mr. Lindley, whilst at Hadfields they were Mr. Whitehouse and Mr. Chanley. Mr. Brown acted as a mobile steward to see that the rules were being observed in the same way in both shops. The judges were Mr. Offiler and Mr. Joyns, whilst Dr. Dadswell helped on judging day with the assessing of marks and the working out of percentages.

Instructions to Entrants

The instructions for the competitors were made as brief as possible. They were each handed a blue print and instructions, and given 15 minutes to read them before the competition started. The instructions to competitors were as follow:—(1) The method of constructing, and arranging for the moulding of the pattern, is left to the competitor; (2) the competitor can choose between nailing or screwing the pattern together; no glue will be provided; (3) no fillets are provided, but if the competitor thinks them desirable, he must mark their position clearly with pencil on the pattern; (4) no glasspaper is to be used on any part of the pattern; (5) the pattern only is to be made. Any competitor constructing his pattern to core any portion must finish off the core prints; (6) the material for which the pattern is made, together with the competitor's name, must be written on the slip provided by the stewards before leaving the competition. Important: The work will be judged on accuracy, suitability for moulding, workmanship, and time taken. A well-made, but unfinished, pattern will have as good a chance as a poorly-made pattern which is complete.

The proper amount of timber was provided, and as soon as the patterns were finished, they were handed to the chief steward, who stamped them with a number, which was also put on the list of competitors' names. All that the judges had were the numbered patterns and a letter indicating the metal with which they were to be made. The judges had no notion as to who made the patterns or where they were made. In sending out particulars of the competition, they mentioned the tools that they considered would be necessary. They gave each competitor exactly the same quantity of timber, which was carefully scrutinised before the competition took place. In one shop there was an objection to the timber, and the competition was held up while a new piece was cut for the satisfaction of the competitor. The speaker added that he felt their thanks were due especially to Mr. Joyns, and to the English Steel Corporation and Hadfields, Limited, who provided the space and the timber for the competition.

Judging

DR. DADSWELL said the methods of assessing the patterns had to be decided, and the basis of the judging was the essential point that Mr. Offiler had in mind when the pattern was designed. In designing the pattern he had embodied certain things, and they decided how many marks should be given to each of those points, depending upon the importance of them. Allowance had to be made for the time factor; the full time of the competition was 4 hrs., and points had to be given for those who finished their patterns in a shorter time. Allowance also had to be made for age. The majority of the marks were awarded on concrete figures. The mouldability was the only point that could not be measured.

Design of the Pattern

MR. G. OFFILER said the pattern was designed so that it might be moulded in four different ways: to leave its own core, made in halves, made solid, and with top side dowelled on and block pattern with half-round hole and chamfered. The block pattern never matured, but all the other methods were produced. They visualised it was possible to make a block pattern and put the majority of the shape in the core. As that was possible, it meant that whichever competitor used that method, he should have as much work to do as a competitor producing a pattern by any of the other methods. Ease of moulding was a very big point, because there were likely to be competitors from shops devoted to non-ferrous, cast iron, steel in all its variations—manganese, ordinary steel, stainless steel—and so forth.

The best method for one kind of material was not always the best for another, and that aroused considerable controversy between the judges before they fixed their definite points to each item. They came to a unanimous decision that, if a pattern was a mouldable job in any of the four ways, it should have an equal number of marks for its mouldability. An important feature was that they were judging work that was done by apprentices and not by journeymen. Apprentices were subject to the instructions given them by their firm, and it was the particular method the firm required that they were accustomed to; thus it was thought best to give an equal number of points for each of the different ways of making. They took into consideration good taper for moulding, reasonable taper, right taper, and also the taper on the prints, as well as taper for closing.

In checking the patterns, they gave to the competitors under 18 points of equal value to the respective importance of each item, and the items they checked first were the correct sizes. The pattern had to be correct to its size. One-sixteenth of an inch was the smallest dimension to work to for those under 18. On one pattern for elder lads there was embodied a measurement of $\frac{1}{32}$ in., in order to see if the apprentice was capable of working to such small dimensions. Another point was working square, and there was a check for being parallel with each type. For the elder lads' work there were checks for the angle; there was one angle of 60 deg. and one of 45 deg. The half-round hole was embodied, first to make the pattern a little more complicated for the block pattern; it had been produced to check the ability of the man to pare a half-round hole without sandpaper.

Points were given for the general finish, which was a tool finish and not a sandpaper finish. Machining allowance was a small but very important detail, and was checked to see that the allowance was located in the correct position for the moulding of the pattern, so that it should be in the right position in the mould. There was a machining allowance for brass, cast iron, steel, and manganese steel. Undoubtedly the sample of work was good, and only two patterns were not completed. That 35 competitors finished in the time allowed was very satisfactory.

First Competition Ever Held

MR. JOYNS referred to the fact of the competition being held at all as showing a very progressive outlook on the part of the Branch. The competitors showed a willingness to acknowledge their limitations and their defects; their work was very good indeed, and this was the general impression of all the judges. On the general question of the patterns, speaking personally, he thought the factor that impressed him most was mouldability, and he was not sure that, given a free hand, he would have come to the same conclusion as did the judges. By mouldability he meant the sense of knowing how the pattern was going to be moulded, and proving that by showing the tapers in the correct way. If he were asked which was the best point on which to judge any pattern, he would unhesitatingly say from the point of view of mouldability, because it was the one thing that young apprentices usually found the most difficult to understand because of lack of opportunity.

Ability to Read Drawings

He thought that almost without exception the competitors proved that they had visualised the job from the start. To do so was a very great asset in patternmaking.

Generally speaking, the order of accuracy was very fair. It had to be remembered that they were dealing with young people, who were working piecework in the sense that a time limit was imposed. The correct use of tools certainly had shown that the apprentice knew his job.

In offering a few small criticisms, the speaker pointed out the necessity of providing centre-

lines, which was an essential part of pattern-making. Another criticism, for which the apprentices could not be blamed, because it was certainly not part of their instructions, was the absence of any indication of where rapping should take place. He never liked to see a pattern left to the mercy of the moulder as to just where he should rap, and he would have been better pleased if, at a certain place, it was indicated where the pattern was expected to be rapped.

Probably the greatest thing apprentices could do was to acquire the habit of visualising any job. If they did not do that they would never be patternmakers in the proper sense of the term. They must understand mould characteristics, and they should ask their employers to give them some time in the foundry. The worst patternmakers one met were usually those who had been trained in detached shops catering for the trade.

The apprentice must understand that he was indirectly producing a casting. The cost of patternmaking should be kept down to its lowest possible point, in the same way as moulding and casting had to be kept down, but there was a tendency for patternmakers to think of a pattern as a pattern, without reference to its purpose. Thus, they must remember that, much as they would like to spend a lot of time in making a really well-finished pattern, the real product was actually the casting.

He was not implying that, when they had to produce a great number of castings off a pattern, they had to eliminate as much patternmaking as possible. That was precisely the opposite of the truth; to spend considerable time on a pattern from which a quantity of castings had to be made reduced the ultimate cost of the castings. But where a pattern had only a very limited production, a serviceable pattern was needed, and not one, probably, which would be well finished and cost a good deal more.

When difficulties arose, the moulder blamed the pattern, and it was the grossest fallacy to imagine that a casting must be like the pattern, because cases were known where the casting was quite unlike the pattern; but one could never convince a moulder of that. Personal experience was that, whether a nail had been left in a loose piece, or a blowhole was on top of the casting, the patternmaker was responsible.

Mouldability a Vital Factor

MR. J. ROXBURGH paid tribute to the work of the sub-committee and the judges for the excellent way in which they had conducted the competition, especially Mr. Joyns, of the British Thomson-Houston Company, Rugby. Like Mr. Joyns, he believed that mouldability was definitely the most important point, but in deciding upon the best method to mould a particular casting it was necessary to know the number of castings required. If for a certain number off, could the pattern be made such that one could make the castings by semi-repetition method, or wholly by repetition method where mechanical means could be used? The first essential was to produce a casting which was as near perfection as possible, and having considered the best method of production from that point of view, then one had to go into more detail. The question of economy had to be taken into account. Sometimes, for the "one-off" job, the pattern shop made a cheap pattern and expense was entailed in the foundry. Another time, with a number off, a good pattern was made, whereby one could make the casting cheaper in the foundry. Many of the difficulties which Mr. Joyns foresaw could, by co-operation with the patternshop, be eliminated. When a pattern left the pattern shop it should be foolproof. He had found cases where a core could be put into a mould in two ways, yet it was an easy matter for the patternshop to take care of such an eventuality. He believed that inspection and checking at as many stages as possible should be enforced, and in a foundry casting intricate work it was essential that the patternmaking should be checked actually in the foundry. The patternmaker should be at hand in order to check the position of the cores, the thickness, and so on.

Mr. Joyns had made the point that, in considering the method of moulding, one must be able actually to visualise the casting before any work was undertaken, and he quite agreed with that statement. As a steward he gave out the drawings and was very pleased to see that within a quarter of an hour of the receipt of the blueprints some of the competitors had decided upon the way they intended that the pattern should be produced.

The CHAIRMAN finally thanked those who took part in the competition and those who organised it. They had done sterling work for the Institute and the Branch.

Deoxidising Agents

MR. R. C. GOOD, in the course of an article on "Deoxidising Agents," published in a recent issue of "Metal Progress," states that every metallurgist realises that the physical properties of solid steel reflect the nature of deoxidation. New principles and methods have been established from time to time and correlations between microscopic examinations and chemical analyses of the oxides have been worked out gradually, so that it is obviously difficult to assign any particular development to one year.

Deoxidation of steel is purposely varied from minimum additions sufficient to control rimming in moulds to a maximum removal of oxygen desired for dense, clean steels acceptable only when the oxygen content is as low as possible. In every case, the best results are procured by basing the deoxidising practice on conditions most likely to prevail prior to the addition of the reagents.

Numerous combinations of elements into one alloy have been proved effective after exhaustive trials and experiments. Some of these alloys are as follow:—

Silico-manganese in proper proportions, when added in the furnace, will form inclusions of low melting point approaching the formula $2MnO.SiO_2$ which float to the surface rapidly; success may be estimated by calculating the amounts of manganese and silicon oxidised. Additions of high-carbon pig-iron ahead of the silico-manganese improve the practice. Ferro-manganese (medium or low carbon) is preferred by operators who wish to avoid CO gas generated after an addition of the high-carbon spiegel, since carbon exerts a powerful attraction for oxygen at high temperatures.

Zirconium-silicon alloys are frequently added in electric furnaces to coagulate and aid the removal of other oxides by lowering their melting points. Zirconium also unites with sulphur and nitrogen, rendering the steel more machinable and malleable. It is commonly used in conjunction with the higher manganese grades, whereupon the steels show less segregation on account of the added deoxidising effect.

Calcium alloys, such as calcium-silicon or calcium-manganese-silicon, are far more effective in removing oxygen than is silicon alone, and the products of deoxidation do not remain in the steel. Since the calcium is strongly basic with respect to silicon, fluidity of both slag inclusions and steel is noticeably improved. From 2 to 6 lbs. per ton are effective when the alloy is added in the ladle.

A grain-refining combination of silicon, vanadium, aluminium and zirconium known as "Silvaz" is also a suitable addition to the ladle. It improves impact resistance and elastic ratio by its influence on the non-metallics. Since combinations of grain-refining elements are often found to be more stable and effective than individual elements, the proper amount of Silvaz provides a clean, fine-grained steel with superior properties.

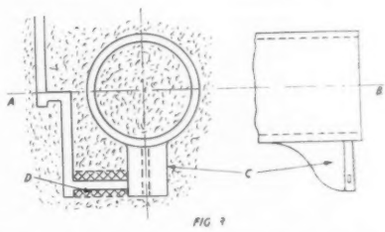
While the above general practices are in common use, the preliminary oxygen content of the steel must be under control—most easily by manipulating the amounts and proportions of the materials and the charging order.

(*Continued in next column.*)

Bottom Runners

BY H. R. THOMAS.

Many factors influence the running of castings, and often runners are cut in unsuitable places because of the difficulty in placing them elsewhere. For many jobs bottom running is ideal; the metal drops outside the actual mould, is led gently in and ascends around the cores forming the interior without scouring. Top running of the same job often results in dirty castings, because of the erosion by the metal of the mould face, especially if of any great depth. Two examples of jobs in which top runners were used with indifferent success, but which were ideal when bottom poured, are shown in the sketches. Both of these jobs exhibited slight difficulty at first in positioning a bottom runner, and the moulder, choosing the line of least resistance, cut runners into the joint, with dirty castings as the result. Fig. 1 shows a portion of one of these castings; it was a circular base plate and reservoir for compressed air. If an ingate from the runner was placed at A a dirty mark would be left on the resultant casting. As face B was machined it was thought best to run on this face, and any marks could then be subsequently removed. Consequently, a runner was made as C (Fig. 2). To produce this it was necessary for a core to be made at D containing this ingate. Down-runner E is placed in position, and the job rammed to F; core D is then inserted, the ramming completed and the whole dried. Two advantages accrue from the use of this runner, the first being the cleaner casting produced by the avoidance of erosion. Secondly the runner, always being made in a core, is of standard size, and no variation takes place, as happens when runners are cut in the top by the moulder.



Another similar job is shown in Fig. 3, which illustrates a portion of a casting. Other details of this casting determined that it should be cast in the position shown, the joint being along the line A B. This casting was originally run on the joint, and invariably on machining the cylinder portion would appear somewhat dirty. A bottom runner was then proposed and ultimately adopted. This entered the foot C and was formed in a core D which, as in the previous example, was rammed up in position with the mould. These examples, although simple, illustrate the principle that bottom running is best for certain jobs, and show the method of overcoming the difficulty of cutting runners into apparently inaccessible places.

A Chemist Looks at the Foundry*

By J. STOTT

Some foundrymen may ask themselves what the chemist can possibly see in their foundry other than a regular flow of good castings and a well-ordered hive of industry. Before any good views can be seen, however, one has to examine the lenses through which the panorama is seen, and in the present case these should be good optical glasses and not rose-coloured, so that criticisms and faults may be revealed and not merely good castings.

The chemist has, or should have, a good technical training which enables him to see a little further than the end of his nose. The appellation "Jack of all Trades," with the usual rider deleted, describes a good chemist. He should be in a position to tackle any problem, and if it is not possible for him to give the sought-for solution, he should at least be able to enter into discussion, and thus help in its solution by suggesting other angles from which the problem may be tackled. His actual contact with the foundry in the daily round brings him in touch with the many sides of foundry activity. He certainly sees the bad castings, and it is possible that he may be the culprit, detective, and even the judge all in one at the inquests on these unusual phenomena.

Chemists have often asked "What is a good casting?" The only time the chemist sees such things is when one happens to be left about, and even then he is liable to cut out a section for micro-examination and take a sample for analysis. Again, he is usually conversant with metal mixtures from the daily analyses conducted, sand control and usually all raw materials, and finally the technical literature. These are part of the telescopic make-up with which he can view the foundry, and it is armed with this metaphorical telescope that the author would like to exhibit the foundry through the eyes of the chemist.

Use of the Metallurgical Chemist

In the early steel age, and also in the age of the steam engine, iron founding was looked upon as a craft, or even as appertaining to the arts. Although pig-irons were being analysed around 1850, not much practical use was being made of the results. Between 1860-70 more and more use was made of chemical analysis, but it was not till later in the nineteenth century, when methods of analysis had been perfected, that the foundry realised the benefit of science in its advancement.

Influence of Chemical Analysis

The application of analysis and of metallography lead to rapid strides being made. Pig-iron, which had originally been classified by fracture, was re-assessed in the light of chemical composition, and the market value was determined by the analysis. However, modern investigations are leading away from mere classification by analysis, which is inadequate in some respects. The modern foundryman, taught by experience, finds that he requires some knowledge of its previous history; heredity is an important factor in determining the value of castings, and there is, for example, as a result, both composition-controlled and structure-controlled pig-iron. With the advance of engineering in such fields as motoring and aviation, new alloys have been produced, in the production of which the chemist has certainly become an integral part of the foundry. He is closely linked with it and the relationship should be one of real understanding.

The chemist is still somewhat despised by some foundrymen, and it is often stated that he could be dispensed with. What brings about this state of affairs and produces animosity? Is it because the chemists are supposed to use a different language that the foundryman is bemused when discussing foundry matters? The chemist can at times be superior in that he may speak in terms of primary cementite, which may or may not be foreign to the foundryman. However, the foundryman ought to recognise that he, too, may talk another language—not one containing technicalities, but what may be termed "practicalities." The chemist may be so accustomed to speaking in the manner indicated that the foundryman goes away saying, "Rubbish," whereas if he had insisted on a simple explanation it would have been forthcoming.

With the advance of technical education a better understanding is being nurtured, and the harmonious working between chemist and foundry is becoming more of a reality and less of a dream. These last few words may be received by some with resentment, inasmuch as they come from a chemist. Nevertheless, a closer co-operation will be possible if the viewpoints of both sides are studied. What upsets a chemist most in his contact with the foundry is being given work to do with no details as to the ultimate object. Naturally, some work may be of such a nature that it is impossible to give complete details; on the other hand, in scores of cases the chemist could save time, valuable not only to himself but to the foundry, if fuller instructions had been given. That is one point where a better understanding could be promoted. Some laboratories exist merely for routine analysis, and the chemist sees little or nothing of the results of that analysis. Thus a potent source of help is lost through the non-appreciation of the laboratories' capabilities.

Language Difficulties

In all scientific subjects a special mode of expression is produced, which to the layman is a disadvantage, as it puts him outside the pale. Only by learning that language can he understand the subject-matter. How else could it be expressed? The whole science of metallurgy is written in a manner which presents some difficulties unless the groundwork is there, and it is extremely difficult to put it simply. The author has tried, when lecturing students, to explain the iron—iron carbide equilibrium diagram in simple language, and it is a difficult task. On the other hand, it is only fair that a spade should be called a spade and not dressed in technicalities.

Another stumbling-block which may lead to misunderstanding is the time factor. To the chemist, certain tasks must take up a definite amount of time before the required result appears. This point is not fully appreciated by the foundry; they grow impatient, and cases are known where they have solved their own problem before the laboratory report was available, and thus the laboratory stock slips back a few points, due to no fault of the laboratory.

The quality of the metal is certainly one of the chief concerns of the foundry chemist, and it is with this aspect in mind that the author takes the first view of the foundry. Whether grey iron, alloy cast iron, non-ferrous metals or steel are cast, the chemist usually controls the ultimate castings produced with regard to composition. Metal mixtures may or may not be in the hands of the chemist, but all raw materials pass through his hands; therefore, he is indirectly concerned with the metal mixture. Some foundries have been known to use the same mixture for years, the original being handed down from father to son; and when supplies of the usual pig-iron have ceased through the blast furnace closing down, they have to resort to new brands. It is then that the chemist "catches it hot," such people usually saying the new mixture is not half so good as before, although tests indicate it to be the better suited for the job. Again, many small foundries have the mixtures used written on a scrap of paper, and one can well imagine them locking it carefully away in the safe at night. These examples are not the general rule, and most foundries now have standardised procedure as regards records.

One point which a chemist cannot grasp is this: The composition of the charge is carefully worked out, melting losses are calculated, and then the charge is given to a labourer to weigh out or even guess. The author has investigated cases where a certain casting was scrapped, due to the composition being wrong, and he has found, not once but several times, that the cause was due to wrong weights being charged, and in one case part of the charge was missed entirely. Such a state of affairs should not be allowed to exist in a modern foundry.

Recent Progress Achieved

The technique of melting, as seen by the chemist, may be at times clouded by the fact that he is in charge of the composition, and the working of the charge depends on his analyses. It is then that the foundry and laboratory are in close co-operation, if not in perfect harmony. He may see the resultant castings, and will certainly get to know their compositions, and he may, perhaps, if they have gone wrong, start a *post-mortem*. This is an occasion when a good foundry chemist is happy in the fact that he has a chance to be of real service to the foundry. Foundrymen all know the hundred and one ailments that the new-born casting is subject to; in fact, it is often asked, due to all these things that can go wrong, "Is there such a thing as a good casting?" There have certainly been rapid strides in melting technique in the past few years, and consequently the metals produced have improved in quality. Cast irons are now regularly produced with tensile strengths of between 20 and 30 tons sq. in., whereas at one time cast iron was always quoted at around 10 to 12 tons sq. in. Whilst the use of alloys has helped to bring about the increase of strength, better melting conditions have helped in no uncertain way.

Heredity being a factor in the classification and use of pig-irons, chemical analysis cannot give any material help, and it is here where the other ally of the chemist, the metallurgical microscope, comes to the fore. Certain castings which may be quite correct as to composition do not fulfil all requirements as to strength, etc. Rate of cooling, temperature of pouring, design of mould, runners and risers can influence the resultant casting to a marked degree. The structural changes can only be diagnosed by the microscope, and in this direction more use is being made of this instrument. Its use in studying graphite formation has thrown new light on this phenomena.

Grey cast iron consists of a steel-like matrix broken by graphite inclusions, resulting from the breakdown of carbides, and also to non-metallic inclusions. The tensile strength of the matrix may be as high as 60 tons per sq. in., but the strength of the whole casting is determined by the degree which the graphite flakes break up the matrix. Thus, the strength of a casting depends on the control of these inclusions. The graphite flakes break the matrix with innumerable fissures, which destroy the strength as a whole. Generally speaking, these fissures are sharp, and as they run in all directions, they tend to destroy not only the static strength, but also the resistance to shock, by providing notches for the development of fracture under impact. To produce high-strength castings it is necessary to minimise the amount of graphite and also the size of graphite flakes, so that they shall be as fine and as widely distributed as possible. Alloys

* Paper read before the Newcastle Branch of the Institute of British Foundrymen, Mr. G. Elston presiding.

have played a part in improving grey cast iron, but with the advance of knowledge, non-alloyed irons are being produced which have remarkable properties. Inoculation has brought about this change, and by suitable additions the graphite is caused to precipitate in fine flakes or rosettes. Meehanite cast iron is an example of this treatment.

Grain Size

Thus, a new aspect which requires control from a scientific standpoint has arisen, and again the microscope is the means of examination. It has been found that the grain size of steel castings determines the heat-treatment, mechanical properties and even appearance, and to obtain the best results this is kept under control. Standards have been compiled by which grain sizes can be compared and steels can be reproduced with identical grain size; thus, results obtained on one particular job can be reproduced. The work conducted on cast iron is now moving along similar lines. Graphite size and form are being assessed and methods examined whereby graphite size in castings can be controlled. It is possible in the near future that foundrymen will not only have to produce castings giving a certain tensile strength, but the graphite flakes present will have to conform to a predetermined size and shape.

Another direction in which cast iron is revealing the versatility of its properties is the application of heat-treatment. Cast irons are now in regular use with properties akin to steel, and in some respects they are claimed to be superior. Who would have thought that highly-stressed parts like motor crankshafts would be made from cast iron?

It is evident, from the foregoing, that the foundryman must be ready for revolutionary changes. How does this affect the foundry? It must surely bring the foundryman and scientist in closer touch, and the time is fast approaching when the foundry itself will take on the guise of a scientific laboratory. Rule-of-thumb methods which have produced good results will have to be re-examined and maybe scrapped. It is not wished to imply that the foundry will be ruled and run by scientists. The foundry will still require those moulders whose skill is only obtained by years of experience and not from text-books. The past few years have borne this out, in that the foundryman is becoming technically minded. Courses in foundry subjects are becoming more popular, and the Institute of British Foundrymen is encouraging and fostering this matter. The foundryman of tomorrow may be both the scientist and practical iron founder, and talk of two languages will then be needless.

Sand Control

Sand has also come to be a material on which much scientific work has been done. Whereas sand was mixed by "feel," a method produced only by experience, technical control has become commonplace. With the growth and extension of mechanical moulding it is imperative that sands should be brought under control and that results may be reproduced. Mechanisation of foundries has also brought about the demand for sand control, and methods of control, as employed in some foundries, have been placed in the hands of the foundry itself, under the supervision of the technical side.

Synthetic sands have been utilised in the past few years, and here the foundryman has the opportunity of preparing a more or less perfect sand. Natural sands are so variable in properties that no two sands are alike, and this is often the cause of trouble in the foundry. A moulding sand which is to give good results must have such properties as: high degree of refractoriness; high permeability; proper bond strength; and even grain size and moisture content.

With synthetic sands, mixtures can be produced by the suitable use of silica sand of selected grain size with a clay bond which has the desired bonding powers, but scientific aid is essential. Some foundries do not worry over sand control, but with proper control pounds could be saved in this direction. The recovery of used sand has become necessary in order to reduce costs, and here, again, the foundryman has employed scientific methods. Mould dressings are also closely linked with sands, and much thought and time has been expended on them. The use of coal-dust is a controversial subject, and once again the practical foundryman must experiment himself or wait for a lead from technical investigators.

Ray Examination

X-ray technology and latterly radium emanations have been applied in the examination of castings. A casting that to every outward appearance is sound and a "good job" can be examined internally by these rays, and no amount of patching and touching up can then save the bad casting. Investigations on the oscillation of the moulds during pouring may lead to application of this process in the everyday production of castings.

Conclusion

What has been said is a view through the eye of a chemist, who makes no claims to a full knowledge of the mysteries of foundry life. Some may not agree with all the above remarks, but it is hoped that they may help to bring about a closer co-operation between foundry and chemist, because all are working for one purpose. That purpose is the production of good castings.

DISCUSSION

The BRANCH-PRESIDENT commented upon the importance Mr. Stott placed on the different languages spoken in the industry as between the practical artisan and the scientific side. He realised himself, as representing the scientific side, exactly where difficulties would be met by the practical man, and he felt that it was up to the scientist to speak in terms more generally understandable. Difficulties again rose, however, as in many cases it was impossible to present in simple terms the technicalities which were part and parcel of metallurgy. He suggested that a Paper would now be very welcome from any practical member, giving the other side of the story, and perhaps entitled "A Moulder Looks at the Laboratory."

MR. JAS. SMITH agreed that there should be considerably more co-operation between the chemist and the foundryman. He caused a great deal of laughter by instancing how, many years ago, the chemist and his activities were unknown in the foundry trade. He stated that when he eventually had contact with a chemist, the unfortunate result was that practically the whole output of a foundry concerned had to be scrapped, owing to incorrect mixing and charging into the cupola.

Mr. Smith provoked a side discussion by stating that the castings in the "Mauretania," of which vessel Tyneside was justly proud, had been made without the aid of the scientist, and that they had given very satisfactory service.

MR. W. SCOTT affirmed that, in order to manufacture the lighter designs of castings, which still had to perform the same functions, very much greater strength was required, as was evidenced by the more stringent specifications to which foundrymen had to work. Therefore, co-operation between the foundryman and the chemist was essential.

MR. GUEST suggested that many faults were due to the training of both the foundryman and chemist. The foundryman should have experience in the laboratory, and the chemist should have experience in the foundry; this combination of technology and metallurgy would be a success.

Considerable discussion took place on the question of training for both the chemist and the foundryman, and whilst some members considered that a chemist had sufficient to do to learn his own profession, it was evident that the majority considered a combination of practical and scientific training as ideal.

MR. C. GRESTY commented at length upon the question of training. He thought the fault lay largely with individuals themselves. On Tyneside, and probably in most other big centres, every facility was given to young operatives and others in the foundry trade to learn practical work, coupled with considerably more than a smattering of scientific work. Yet it was becoming more and more difficult to persuade the younger men and apprentices to take up this training.

MR. STOTT expressed agreement with Mr. Gresty, having experienced exactly the same thing in another district; but he looked forward to the time when both the scientist and the practical worker would see eye to eye as a result of sound early training.

In conclusion, the BRANCH-PRESIDENT proposed a vote of thanks to Mr. Stott for presenting a Paper which had given rise to an interesting discussion and free exchange of views. This was seconded by MR. T. B. BURROWS.

Use of Blow Lamps

A memorandum on the use of blow lamps in factories has been prepared by the Factory Department of the Home Office, and published as Form 819 by H.M. Stationery Office (price 2d.). Briefly, a description of typical blow lamps for use with petrol and with paraffin is given, accompanied by diagram, which includes one of an excellent design of safety valve. The following points are emphasised: Petrol and paraffin blow lamps are constructed for burning their respective liquids, and petrol should never be used in a paraffin lamp; nor should petrol be used in a lamp with a pump fitting. A safety valve is essential on both kinds of lamps, and it should be of such design as to make it difficult for the worker to put it out of action. The paraffin lamp should carry, in addition to the safety valve, an air relief valve by means of which the lamp can quickly be put out. In each type of lamp the filler tubes should extend into the container far enough to allow of an air or vapour space of one-quarter the container's capacity. The lamps should be lighted in the manner recommended by the maker, and should not be heated either on stoves or by another lamp.

Tees-side's Steel Trade

The iron and steel industry on Tees-side was the subject of an address in the Dorman Museum, Middlesbrough, by Mr. J. T. Gleave, of Durham University. Ironworks first came to Tees-side, he said, because it possessed a site which was pre-eminently suitable for the assembly of raw materials on account of its transport facilities and proximity to supplies. The birth of steel, however, dealt a severe blow to the iron industry. Mr. Gleave, with the aid of statistics, showed that Tees-side's iron and steel industry has not yet regained its pre-war prosperity. Actually steel production had been exceeded, but local ore output and pig-iron production had declined considerably. Figures showed that Middlesbrough's exports had fallen from £8.2 millions in 1907 to £5.8 millions in 1935. Similarly, the ironstone output of 6,765,055 tons in 1883 had fallen to one million tons in 50 years. Pig-iron production since 1913 had fallen by approximately one and a half million tons, with a drop in the exports of nearly one million tons. Concluding, Mr. Gleave said that Tees-side at the moment was Britain's chief steel-producing centre, but he questioned how long that position would be maintained. Cleveland supplies, at the present rate of production, would last only another 60 years, whereas those of Northants would last 500 years. He was of the opinion, however, that Tees-side's skill and experience in the industry and natural geographic and economic advantages, would give a sufficient start to meet any competition which might increase in the future.

Of interest to Pig Iron Users

THE STANTON METALLURGICAL SERVICE

The Stanton Company believe that a mutual policy of collaboration in more scientific and better methods of manufacture, can do much to widen the field for cast-iron products.

The Stanton Company therefore offer to all those engaged in the Iron Foundry Trades the free advisory service of specialists in metallurgical practice and technique.

This service takes the form of analyses and tests by the Company's Research Department on castings submitted to them, and constructive suggestions if the desired results are not being attained.

Where there are difficulties in works practice which can best be investigated on the spot, the service provides for a personal visit from a Stanton metallurgical expert, who will collaborate with the foundry staff.

THE STANTON IRONWORKS COMPANY LIMITED
Near NOTTINGHAM

The Largest Producers of Foundry Pig Iron (for Sale) in Great Britain

The Week's News in Brief

Trade Talk

THE FIFTEENTH ANNUAL Refractories Association Ball will be held on January 13 at the Royal Victoria Hotel, Sheffield.

THE SKINNINGROVE IRON COMPANY, LIMITED, will restart two of their blast furnaces on January 2. Owing to heavy stocks and decreased consumption, the whole of the blast-furnace plant has been idle since August last.

A 16-MM. film depicting the manufacture of electric motors and dynamos has been made by Higgs Motors, Limited, of Witton, Birmingham, 6, who inform us that they are prepared to loan the film free of charge to recognised engineering and allied societies.

PETTERS, LIMITED, on the occasion of the impending departure of the company from Yeovil, distributed £2,000 in bonuses this Christmas among employees who have had twenty years or more service with the company. More than 170 employees qualified for the gift.

IT HAS been decided to wind up the London Iron and Steel Exchange at the end of this year. For some time it has been apparent that, owing to the changes in trading consequent upon the reorganisation of the iron and steel industry, the Exchange could no longer fulfil many of the functions for the performance of which it was established.

A NEW Admiralty laboratory was opened at Sheffield recently by Sir Wm. Bragg, in the presence of the Lord Mayor of Sheffield, the Master Cutler, vice-chancellors and professors of metallurgy from several universities, directors and chief metallurgists of various steel companies, and officers representing the three Defence Departments.

SAID TO BE the largest engineering undertaking in Wales, the new I.C.I. Engineering Works, at Landore, Swansea, will commence production during March of next year. Although it was at first suggested that 600 men would be employed at the start, it is now understood that there is a distinct possibility of two shifts being started, with an employment roll of nearly 1,200 people.

HEAD, WRIGHTSON & COMPANY, LIMITED, of Thornaby-on-Tees, have received an order from the English Steel Corporation for a 300-ton main-line bogie wagon, designed for use in the Penistone Works, Sheffield, with a working load of 300 tons, and for use on open line working up to 200 tons. It is believed that this wagon will be the largest in the world. It will be entirely welded and built of high-tensile steel, and will be 60 ft. long over the buffers.

IT IS understood that the Bankers' Industrial Development Company—a subsidiary of the Bank of England—will co-operate in an acquisition by the United Steel Companies, Limited, of shares of John Summers & Sons, Limited, steel-sheet rollers, of Shotton, Chester. It is understood that the United Steel Companies will acquire about 40 per cent. of the 2,000,000 £1 ordinary shares of John Summers which are privately held, with an option to take up further shares at a later date to acquire a controlling interest in the company.

MAKING factory employees more aware of their responsibilites under the new Factories Act is the purpose of two posters recently issued by the National "Safety First" Association as part of the service offered jointly by that body and the Industrial Welfare Society. The first draws the attention of employees to their duties under Section 119 of the Act, which requires them to make proper use of the safety and health appliances provided by law and which makes it an offence for them to do wilfully or without reasonable cause anything liable to endanger themselves or others. The second deals with operations at unfenced machinery. The posters are obtainable from the National "Safety First" Association, 52, Grosvenor Gardens, London, S.W.1.

Obituary

WE REGRET to announce the death, following a road accident, of Mr. C. H. Smith, of 467, Osmaston Park Road, Derby, a valued member of the East Midlands Branch of the Institute of British Foundrymen.

Personal

COL. J. H. M. GREENLY has accepted an invitation to serve on the new Industrial Panel for the purpose of liaison with the Air Ministry Advisory Panel, of which he is a member. Col. Greenly is chairman of Babcock & Wilcox, Limited.

MR. J. G. GOODENOUGH has resigned his position as director and general manager of Dorman, Long & Company, Limited. Mr. Goodenough, who joined the firm's central engineering department in 1932, became assistant to the managing director, the late Mr. Lawrence Ennis, in 1935, and two years later was appointed general manager. Also in 1937 he joined the board of directors.

SIR ROBERT HADFIELD has been honoured by the American Institute of Mining and Metallurgical Engineers in recognition of 50 years' support as a member. The honour carries with it a diploma, and a gold pin, insignia of the Legion of Honour of the Institute. Owing to ill-health, Sir Robert will be unable to accept the diploma and pin in person at the annual dinner of the Institute in New York next February, and other means will be found by the Institute to invest him with the honour.

Will

BRACKENBURY, H. I., late director of R. W. Hawthorn, Leslie & Company, Limited, shipbuilders and engineers ...	£48,711

Company Reports

George Kent, Limited.—Interim dividend of 3 per cent. on the ordinary shares.

Cannon Iron Foundries, Limited.—Net profit for the year ended September 30 last, £23,211; taxation, £18,212; preference dividend, £8,044; carried forward, £7,942. No dividend is declared on the ordinary shares. Meeting, December 30.

British Oxygen Company, Limited.—Dividend of 3¼ per cent. on the 6½ per cent. cumulative preference shares for the half-year ending December 31, and dividend of £1 13s. 8d. per £100 stock on the 5 per cent. cumulative second preference.

Marshall Sons & Company (Successors), Limited.—Profit for the year ended September 30, £100,434; depreciation, £7,159; income tax and N.D.C., £31,500; brought in, £19,979; interim dividend of 2½ per cent., £9,062; to general reserve, £30,000; final dividend of 5 per cent., £18,125; carried forward, £24,567.

Joshua Bigwood & Son, Limited.—Trading profit for the 14 months ended September 30, £26,570; available after providing for depreciation, &c., setting aside £5,142 for taxation, and placing to capital reserve profits amounting to £1,966 earned prior to incorporation, £13,175; dividend of 10 per cent. on the ordinary shares; to general reserve, £4,000; carried forward, £1,633.

J. Brockhouse & Company, Limited.—Profit for the year to September 30, after charging depreciation, £141,741; preference dividend, £1,106; interim dividend on the ordinary stock of 7½ per cent., £27,187; written off expenses of issue of 5½ per cent. unsecured convertible stock, £3,981; to reserve against depreciation of investments, £15,000; to taxation reserve, £45,000; dividend on the ordinary stock of 7½ per cent., making 15 per cent., £27,187; carried forward, £22,278.

R. A. Lister & Company, Limited.—Profit for the year ended September 30, 1938, after making provision for depreciation and contingencies, £245,023; brought in, £69,143; income tax, £72,092; N.D.C., £12,400; preference dividend, £13,275; ordinary interim dividend of 5 per cent., £23,172; proposed final dividend of 5 per cent. and bonus of 7½ per cent., £57,930; commissions to directors and staff bonus, £32,501; additional pensions reserve, £7,500; to general reserve, £25,000; carried forward, £70,296.

Broom & Wade, Limited.—Trading profit for the year to September 30, £81,899; depreciation, £10,553; profit of subsidiary company, £5,690; bonus to employees, £3,567; additional remuneration of directors, £11,700; income tax and N.D.C., £8,035; brought in, £21,909; dividends on the 6 per cent. cumulative preference shares, £6,900; interim dividend of 7½ per cent. on the ordinary shares, £11,250; additional provision for taxation, £8,000; final dividend on the ordinary shares of 15 per cent., £22,500; carried forward, £25,767.

Company Meetings

Birmid Industries, Limited

Presiding at the annual meeting of Birmid Industries, Limited, MR. CYRIL C. MAUDSLAY (chairman) reported a further expansion of turnover. Birmetals, Limited, had now reached full production. In the Birmingham Aluminium Casting Company they had been busy in all departments. The die foundry, which for some time past had been slack, had latterly become well occupied. The sand casting foundries had had as much work as they could turn out, and the foundry erected specially for aero castings had been taxed to its utmost limits. The pressure die department, which was still further developing its trade in zinc base alloy precision castings, had been distinctly busy. The output of the steering wheel department was continually on the increase. The increase in the use of magnesium elektron castings (for aircraft purposes principally) had been remarkable. With regard to iron casting, there had been a falling off in this branch of their business, but this had been solely due to the slackness in the motor trade. Their component company at Coventry, Sterling Metals, Limited, had had a most successful year's trading, their works having been especially busy. He thought they could look forward with confidence to another year's successful trading in 1938-39.

Ley's Foundries & Engineering, Limited

The annual meeting of Ley's Foundries & Engineering, Limited, was held at Derby recently. MR. FRANCIS D. LEY, who presided, said that, due to the general falling off in trade, Ley's Malleable Castings Company suffered its first check for many years in a long record of progressive expansion of output and turnover, but the contraction in normal trade was partly offset by orders for material required in connection with the Government's rearmament programme. The Ewart Chainbelt Company succeeded in improving upon its turnover of the previous year. He mentioned last year that they had decided to increase their foundry capacity. They had now efficient equipment for producing 600 tons of castings per week at an economical price. In addition to new melting and moulding plants, they had installed annealing equipment of an improved design which gave exceptionally close temperature control and constituted a valuable addition to their existing pulverised coal ovens and electric short-cycle annealing ovens.

New Companies

(From the Register compiled by Jordan & Sons, Limited, Company Registration Agents, 116 to 118, Chancery Lane, London, W.C.2.)

Jarrow Shipbreaking Company, Limited.—Capital, £50,000. Directors: Sir J. Jarvis, Bt., M.P., Hascombe Court, Godalming; Major T. G. Bird, F. Williams and W. Scott.

Metal Alloys (South Wales), Limited.—Capital, £1,000. Directors: Sir Thomas G. Jones and J. W. E. Jamieson. Subscriber: D. D. C. Giddins, Skreens Park, Willingale, Essex.

International Alloys, Limited.—Capital, £350,000. To acquire all or part of the undertaking of, and amalgamate with, I. A. (1931), Limited, and to carry on the business of manufacturers and suppliers of aluminium and other metals, etc. Subscriber: G. H. Dennehy, 1, Threadneedle Street, London, E.C.2.

Contracts Open

Birkenhead, January 9.—Iron castings, wrought iron, mild-steel reinforcement, etc., for the year ending March 31, 1939, for the Corporation. The Borough Engineer, Town Hall, Birkenhead.

Croydon, January 3.—Supply and erection of sewage pumping plant, comprising centrifugal pump, electric motor, accessories and pipework, for the Town Council. The Borough Engineer, Town Hall, Croydon. (Fee £2 2s., returnable.)

Longford.—Supply and fitting-up of a 20-ton weighbridge, for the County Council. Mr. J. J. Murphy, county surveyor, Courthouse, Longford, Eire.

Richmond (Surrey), January 12.—Ironfounders' work, etc., for the Borough Council. The Borough Engineer, Hotham House, Heron Court, Richmond.

Santiago, January 10.—5,000 m. of cast-iron piping of 50 mm. dia.; 3,000 m. of 75 mm.; 2,000 m. of 100 mm.; 1,000 m. of 150 mm.; and 500 m. of 200 mm. dia., for the Directorate-General of State Supplies. (D.O.T. reference T. 30,361/38.)

TOR ROCK SAND
for the
FOUNDRY

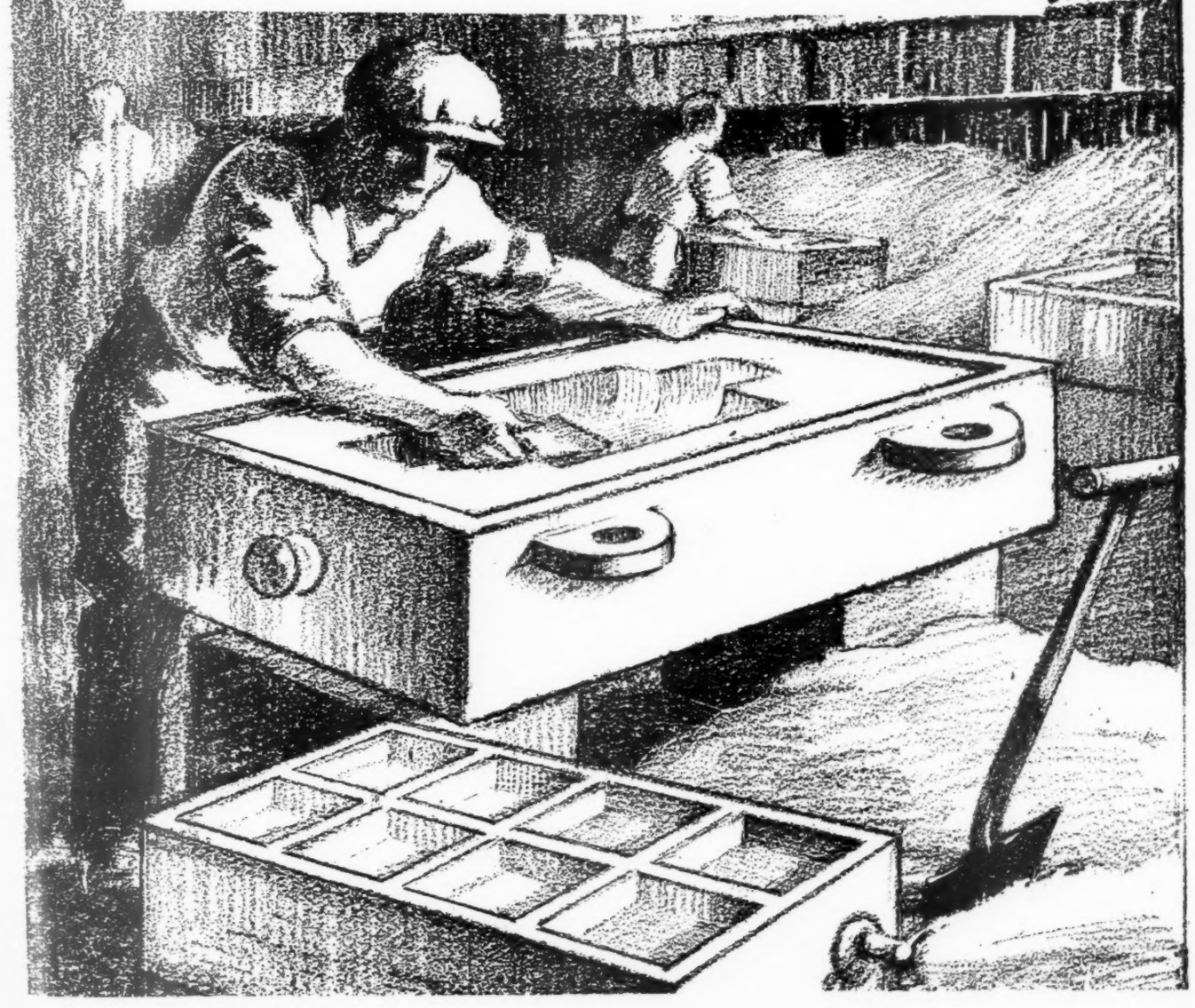
Higher casting temperatures in iron foundries—particularly in those where special alloys are melted—have resulted in a demand for a moulding sand to withstand severe conditions and produce sound castings of good finish. Tor Rock Sand has proved to be specially suitable for these requirements. It is coarse in grain and highly permeable and being somewhat irregularly graded, tends to give a strong and compact mould surface.

Please write for full particulars and sample:

GENERAL REFRACTORIES LIMITED
GENEFAX HOUSE, SHEFFIELD.

Telephone: 31113 (6 lines).

Telegrams: "Genefax, Sheffield."



Raw Material Markets

As announced in our last issue, prices of high-phosphorus and forge pig-iron have now been fixed for deliveries in the New Year, which will open on quite a confident note in all sections, with the exception of the export trade. The reduced scale of prices is insufficient to induce foreign buyers to purchase British material, as Continental iron may still be obtained more cheaply. When trade again returns to normal, following the Christmas and New Year holidays and the annual inventories, it is anticipated that many consumers will have substantial orders to place.

Pig-Iron

MIDDLESBROUGH.—Owing to the incidence of the holidays, there is little to report in this area, but the future is viewed with confidence and it is hoped that business will shortly be resumed on a much greater scale than has recently been the case. The new prices come into operation on January 1 and consumers have suspended contract deliveries until then. It is difficult to estimate just what business will be placed in the near future, but many consumers are known to have practically cleared their stocks. Producers will no doubt keep a close watch on the position and will not be slow to expand their present limited outputs if occasion arises. In fact, it has already been announced that two furnaces at the Skinningrove Ironworks are to be relighted in the immediate future. Not all the iron from these furnaces will be available for sale on the open market, as some will be required for steel-making purposes. For delivery in the Middlesbrough and Falkirk districts, the new prices of Cleveland iron are: No. 3 G.M.B., 99s.; No. 1 foundry, 102s.; No. 4 foundry and No. 4 forge, 98s., all less 5s. per ton rebate. Deliveries on Clydeside are invoiced at 3s. above the foregoing quotations.

The outlook in the hematite section of the trade is less bright, as most consumers are already in possession of heavy stocks and their contract commitments will not be liquidated for a considerable time in many cases. Nevertheless, it is expected that the needs of the steelmakers will be much larger in the New Year, while the consumption of other trades is likely to be on a heavier scale. It is unlikely that the production of hematite will be increased for some time, as producers themselves have considerable stocks on hand. The new prices of hematite, inclusive of delivery on the North-East Coast, are 120s. for East Coast mixed numbers, 125s. 6d. to Sheffield users and 131s. to consumers in the Midlands.

LANCASHIRE.—The New Year looks like opening on a satisfactory note in this area; many foundry iron users have cleared much of their stock and will need to buy additional tonnages at the reduced prices, which have been welcomed, despite the fact that many consumers considered that they might well have been made known a few weeks earlier. For delivery in the Manchester price zone, Derbyshire and Staffordshire No. 3 foundry iron will be quoted at 104s., with Northamptonshire No. 3 at 102s. 6d. Although many foundries, notably the light-castings makers, are still badly situated for work, it is hoped that there will be greater activity within a short time. Likewise, hematite consumers are not too well placed, but there are expectations of more orders after the turn of the year.

MIDLANDS.—As a result of the lower quotations for high-phosphorus foundry and forge pig-irons, business is expected to be on an increased scale in the New Year, when consumers are likely to enter into new contracts. The past week, of course, has been exceptionally dull and no trade has been done. For delivery to Birmingham and district, Derbyshire No. 3 foundry iron will be quoted at 101s., with Northamptonshire No. 3 at 98s. 6d. Forge pig-iron will be 1s. to 3s. below the corresponding No. 3 foundry quotation. No revision of low-phosphorus iron prices has as yet been made and it is not expected that any substantial reductions will be granted. Hematite consumers will be able to take up the unexpired portions of their contracts at the new prices, and, as these are substantial in most instances, there will not be very much new business transacted over the first part of the year.

SCOTLAND.—Scottish pig-iron makers have intimated a reduction of 12s. 6d. per ton in the prices of No. 1 and No. 3 foundry iron, making their quotations 108s. and 105s. 6d. respectively. These prices are to stand until further advised, there being no fixed period, commencing January 1. No. 3 Cleveland iron has been reduced by 10s. per ton, making the price £4 19s., delivered Falkirk, and £5 2s., delivered Glasgow. Now that the prices for delivery after the turn of the year have been announced it is expected that there will be more business in the market. The steelworks are heavily in arrears with their pig-iron contracts and will have no need for further supplies for a long time. Steel-making irons are quoted at: Hematite mixed numbers, 120s. 6d.; Scottish basic, 100s.; English and Indian basic, 92s. 6d., all less 5s. rebate, delivered steelworks.

Coke

Most consumers being well bought, there is little business going through on the foundry-coke market. Moreover, there is little incentive to buy, as prices have been stabilised up to the end of the first half of the year. For delivery in Birmingham and district, best Durham foundry coke is quoted at 50s. 6d., with Welsh coke at a minimum of that figure.

Steel

All sections of the steel industry have been idle during the past week, owing to the Christmas holiday. In many cases, consumers are taking advantage of the stoppage to carry out necessary repair work. A general resumption will be made early in the New Year, when it will be possible to test the reduced quotations.

Scrap

The past week has been very quiet, owing to the holiday, and business has been suspended. It is anticipated that there will be a better demand for most grades in the New Year, as consumers will be able to buy at the reduced quotations.

Metals

Copper.—Business has naturally been at a very low ebb this week. The London Metal Exchange closed after the morning session on Friday and did not reopen until yesterday (Wednesday). In view of the annual stocktaking operations which are generally carried out early in the New Year, it is unlikely that there will be much activity for some weeks.

Metal Exchange quotations were as follow :—

Cash.—Wednesday, £44 to £44 1s. 3d.; Thursday, £43 17s. 6d. to £43 18s. 9d.; Friday, £43 18s. 9d. to £44 1s. 3d.; Wednesday, £44 1s. 3d. to £44 2s. 6d.

Three Months.—Wednesday, £44 3s. 9d. to £44 5s.; Thursday, £44 2s. 6d. to £44 3s 9d.; Friday, £44 5s. to £44 6s. 3d.; Wednesday, £44 6s. 3d. to £44 7s. 6d.

Tin.—Just before the holiday there was a rather better tone in this market. Buyers showed more interest, which was largely based on hopes of industrial recovery in the New Year. Another factor which helped to strengthen the market was the reduction in the basis price of Welsh tinplates, and it is expected that tinplate mills will be better placed for orders within a short time. The turnover in tin during the past week, of course, has been very small. The rooms of the London Metal Exchange will be closed on Monday next, January 2.

The December issue of the Statistical Bulletin, of The Hague office of the International Tin Research and Development Council, states that world tin production in the first 10 months of 1938 amounted to 127,900 tons, against 164,200 tons in the corresponding period of 1937. The decrease is entirely accounted for by the signatory countries, which produced 104,700 (141,100 in 1937) tons in this period, whereas outside production at 22,500 (22,100) tons showed a slight increase. World production in October amounted to 13,600 (16,800) tons. World apparent tin consumption in the first 10 months of 1938 amounted to 129,400 (166,500) tons. World consumption in October amounted to 14,000 (18,800) tons. World tinplate production in the first 10 months of 1938 amounted to 2,399,000 (3,689,000) tons, being a decrease of 35 per cent. as compared with the corresponding period of 1937. Visible stocks of tin decreased by over 800 tons during November to 29,532 tons, against 23,327 tons at the end of November, 1937. These stocks are equivalent to a consumption of about 10 (7) weeks.

Official quotations were as follow :—

Cash.—Wednesday, £214 to £214 5s.; Thursday, £214 10s. to £214 15s.; Friday, £215 to £215 10s.; Wednesday, £215 7s. 6d. to £215 10s.

Three Months.—Wednesday, £215 2s. 6d. to £215 5s.; Thursday, £215 10s. to £215 15s.; Friday, £216 5s. to £216 10s.; Wednesday, £216 10s. to £216 12s. 6d.

Spelter.—This market is likely to remain in its present quiet state until after consumers have finished stocktaking. At present, the market lacks any definite lead.

Daily market prices :—

Ordinary.—Wednesday, £13 17s. 6d.; Thursday, £14 1s. 3d.; Friday, £13 18s. 9d.; Wednesday, £13 18s. 9d.

Lead.—The undertone of this market is quite sound, but, owing to holiday and stocktaking interruptions, there is unlikely to be much activity for the next few weeks. The "Ministry of Labour Gazette" states that building plans approved in November were valued at £6,462,400, against £8,164,700 in November, 1937. The National Federation of Building Trade Operatives estimates that something like 250,000 men are temporarily idle in the industry owing to frost and inclement weather—a larger number than has been out from this cause for many years. This reduced activity in the building industry is reflected in the demand for lead.

Day-to-day quotations :—

Soft Foreign (Prompt).—Wednesday, £15 2s. 6d.; Thursday, £15 1s. 3d.; Friday, £15 2s. 6d.; Wednesday, £14 17s. 6d.

Patent Specifications Accepted

The following list of Patent Specifications accepted has been taken from the "Official Journal (Patents)." Printed copies of the full Specifications are obtainable from the Patent Office, 25, Southampton Buildings, London, W.C.2, price 1s. each. The numbers given are those under which the Specifications will be printed and abridged, and all subsequent proceedings will be taken.

492,791. TRIGGS, W. W. Method of annealing.

492,823. STEPHEN & SONS, LIMITED, A., and STEPHEN, J. G. Apparatus for sand-blasting metal surfaces.

492,855. SIEMENS & HALSKE AKT.-GES. Charging skips, more particularly for charging furnaces.

492,896. LEMOINE, R. P. Degasifying and killing liquid steels.

492,900. CROSSE & BLACKWELL, LIMITED, SUMNER, C. G., JOHNSON, R. I., and CLAYTON, W. Protecting metal surfaces by electrodeposition.

High-Duty Cast Irons

(*Continued from page* 484.)

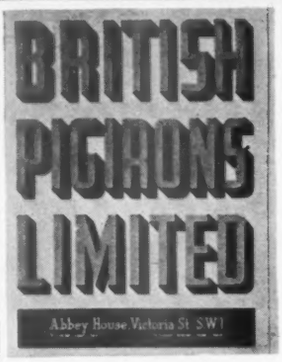
may be used, and the silicon in solution helps the matrix to resist oxidation, as it does in the silicon steels. The austenitic irons "Nicrosilal" and "Ni-resist" have extremely good resistance to growth and scaling and can be used up to relatively high temperatures. They are not recommended for sulphurous gases.

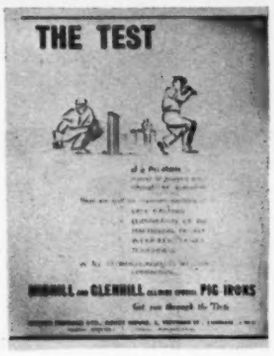
An aluminium-chromium cast iron is now being developed for heat resistance under the name "Cralfer," for these elements improve heat resistance to a marked degree. Irons containing silicon and aluminium are apt to be brittle in the cold but are much stronger at operating temperatures than pearlitic irons.

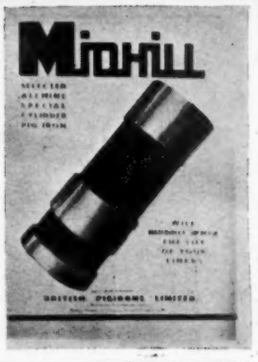
For data on creep strength and other properties the Paper by Becker, Tapsell and Conway may be consulted.*

* Tapsell, H. J., Becker, M. L., and Conway, E. G. "The Behaviour of Five Cast Irons in relation to Creep and Growth at Elevated Temperatures." Journ. Iron and Steel Inst., 1936, vol. 133, p. 303.

(*To be continued.*)







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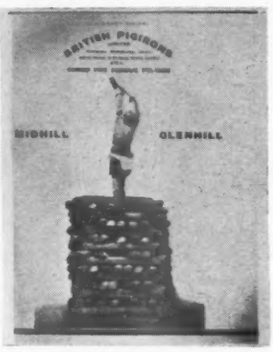

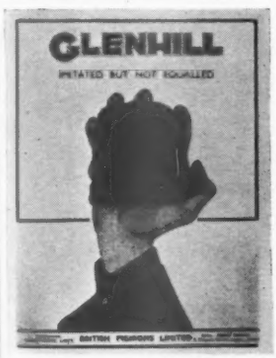

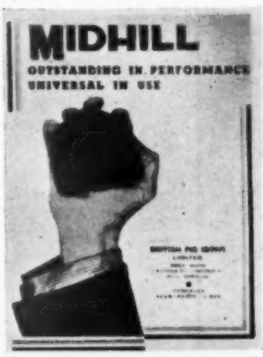

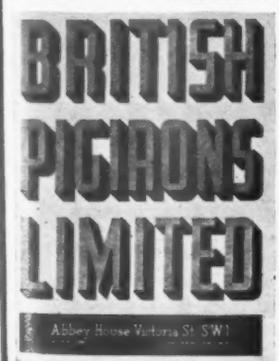

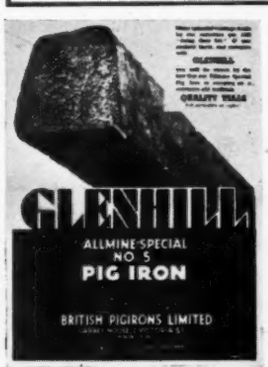

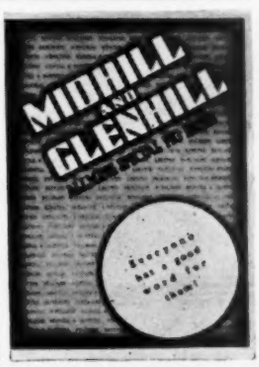

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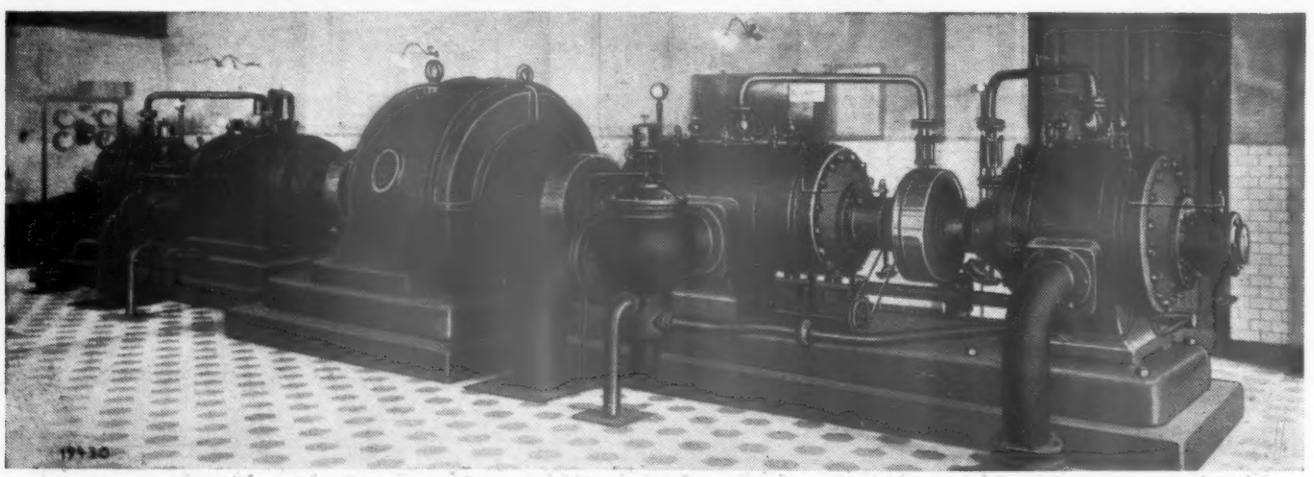

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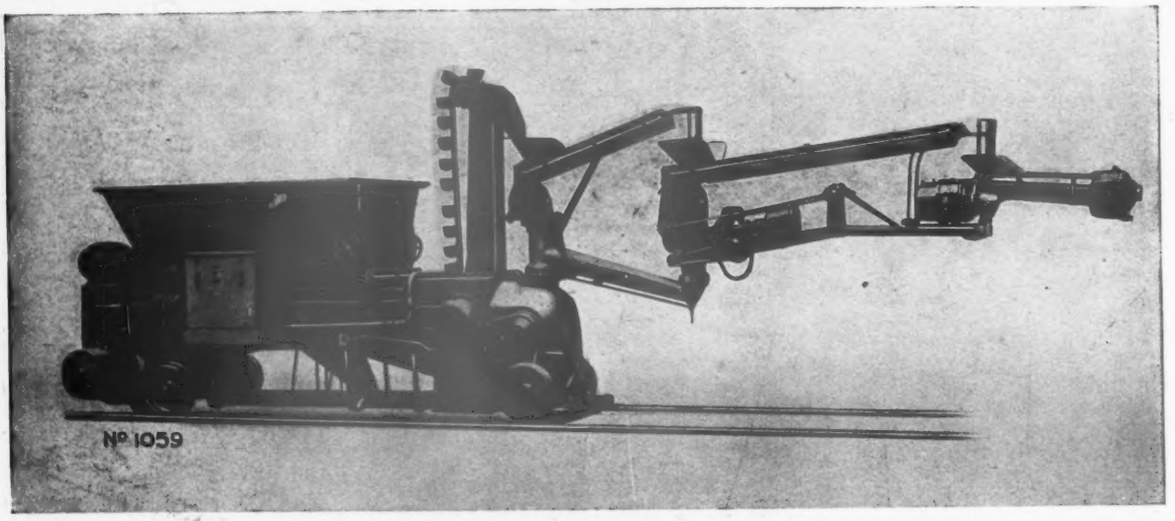

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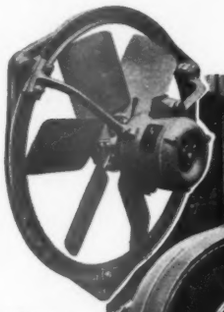
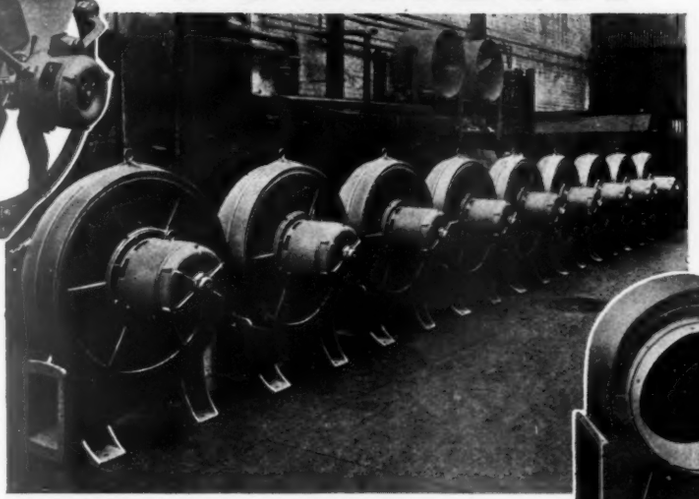


Above : Electric Blackman Propeller Fan.



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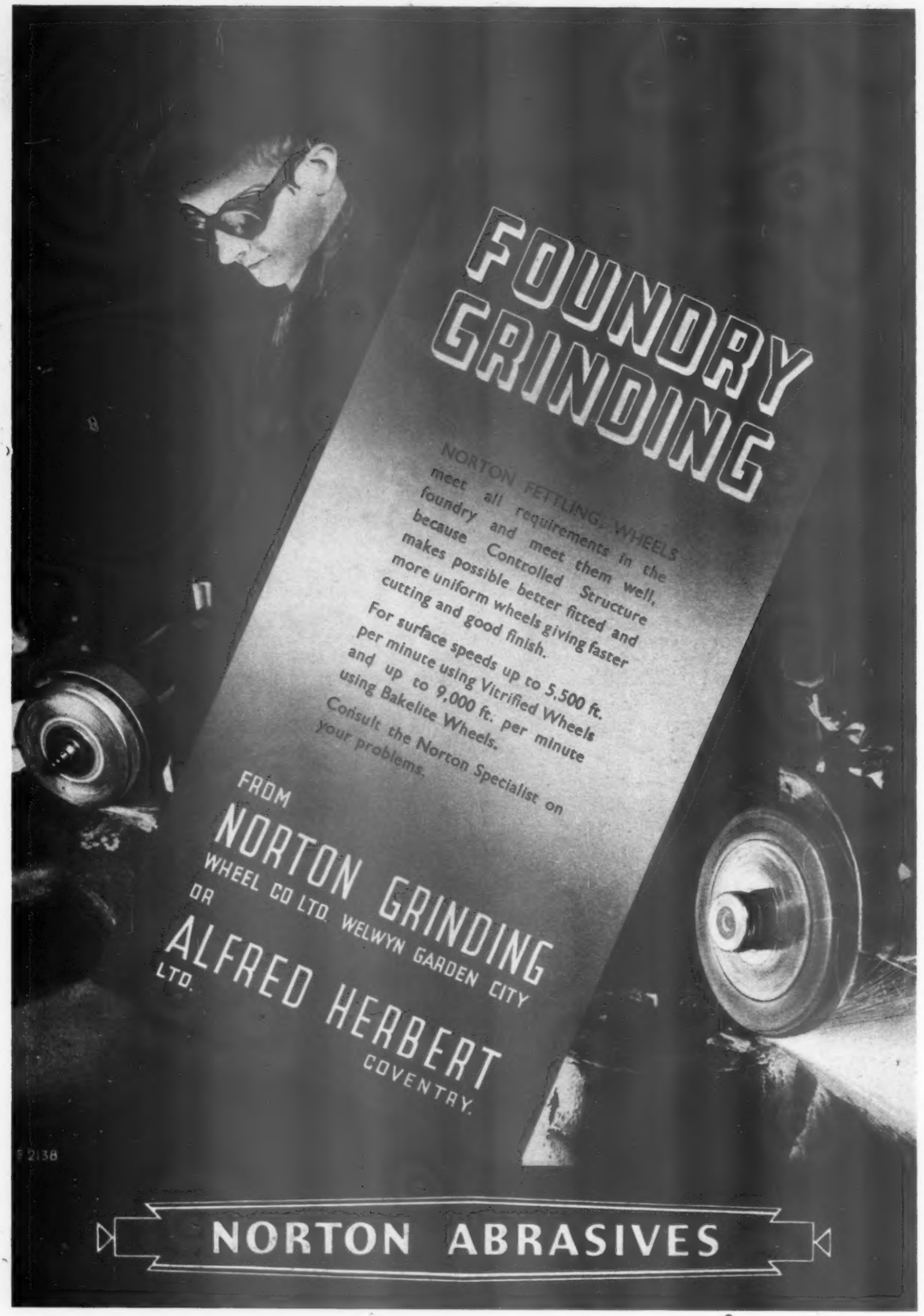
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Safety Products, Ltd.	—
Schilde Maschinenbau, A.-G.	—
Sheepbridge Coal & Iron Co. Ltd.	—
Shotts Iron Co., Ltd., The	21
Smeeton, John A., Ltd.	—
Smith, Albert, & Co.	—
Smooth-On Mfg. Co.	21
Sommerfield, H. G., Ltd.	—
Spencer & Halstead, Ltd.	—
Spermolin, Ltd.	—
Stanton Ironworks Co., Ltd., The	489
Staveley Coal & Iron Co., Ltd.	—
Steel, John J.	—
Steele & Cowlishaw	—
Stein & Atkinson, Ltd.	—
Stein, J. G., & Co., Ltd.	—
Sterling Foundry Specialties, Ltd.	—
Sternol, Ltd.	11
Stewarts and Lloyds, Ltd.	—
Tallis, E., & Sons	—
Teisen, Th.	—
Thermic Equipment & Engg. Co., Ltd.	—
Thomas, G. & R., Ltd.	13
Tilghmans Air Compressor Co.	—
Tilghman's Patent Sand Blast Co., Ltd.	4
United Steel Companies, Ltd., The	—
Universal System of Machine Moulding & Machinery Co., Ltd.	—
Utard, Société des Etablissements	—
Vaughans (Hope Works), Ltd.	—
Vickers-Armstrongs, Ltd.	—
Walker, I. & I.	24
Ward, Thos. W., Ltd.	1 & 16
Waring Bros	—
Warner & Co., Ltd.	—
Watson's (Metallurgists), Ltd.	18
Wengers, Ltd.	—
West Midland Refining Co., Ltd.	—
Wilkinson, Thos., & Co., Ltd.	—
Woodward Bros. & Copelin, Ltd.	—
Workington Iron & Steel Co. (Branch of The United Steel Companies, Ltd.)	—

August's

A double No. 2 August's Composite Sand Plant on Steel Foundry Sand.

Courtesy of Messrs. Edgar Allen & Co., Ltd.

Where the problem is intricate, where experience is essential, where certainty of performance and efficiency of operation are of paramount importance, there you will find an "*August's*" installation, because August's are

"The Specialists in Foundry Mechanisation"

whose products

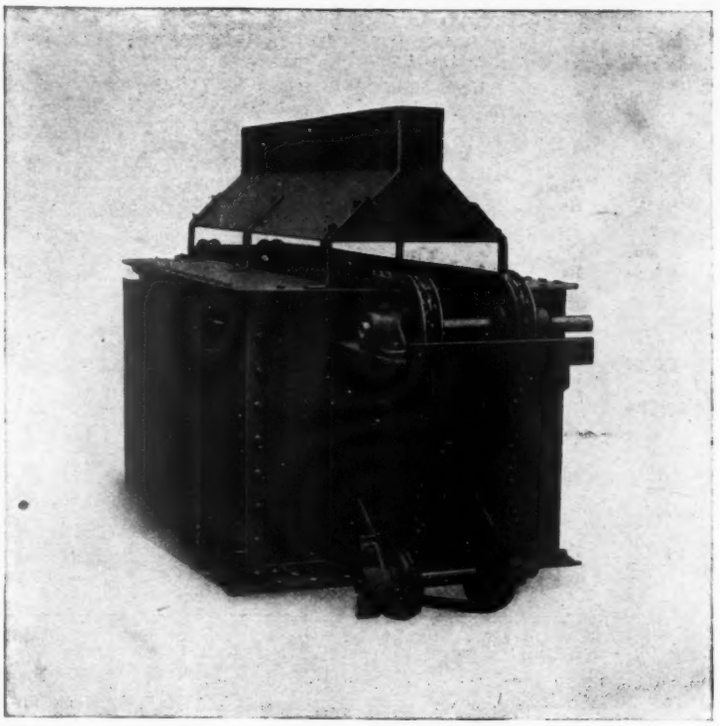
"Set the Standard by which Foundry plant is judged."

August's

LIMITED

'Phones 61247 & 8. **HALIFAX, ENGLAND** 'Grams: August, Halifax.

Sole Licensees and manufacturers for British Empire (excluding Canada) of the Simpson Sand Mixer



CONTINUOUS CHAIN FURNACE

FOR LOCAL HEATING, HEATING FOR JOGGLING FISHPLATES, etc., etc.

Illustration shows oil-fired furnace, but any type can be arranged to suit requirements.

FURNACES, STOVES, SAND PLANTS

SPECIALISTS

COGGON FOUNDRY EQUIPMENT LTD Ovenden HALIFAX

Phone: 2423 Halifax Grams: COGGON, HALIFAX

"TITAN"

Low Phosphorus Scotch Quality

ALL-MINE PIG IRON

G. & R. THOMAS LTD

HATHERTON BLAST FURNACES

BLOXWICH • STAFFORDSHIRE

Telegrams: Thomas, Bloxwich Telephone: Bloxwich 6341

RAW MATERIALS—PRICE LIST

(Wednesday, December 28, 1938)

(The prices given below are those current at the above date. The following reductions become effective on January 1 next:—High-phosphoric foundry and forge pig-irons, 10s.; basic, 7s. 6d.; hematite, 12s. 6d.; finished iron, 20s.; ship plates, 17s. 6d.; joists and sections, 12s. 6d.; heavy rails, 12s. 6d.; soft billets and sheet and tinplate bars, 10s.; soft wire rods, 18s.; merchant bars, hoop and strip, 12s.; black sheets, 20s.; galvanised sheets, 25s.; steelworks' scrap, 8s. 6d.)

COPPER

	£	s.	d.
Standard cash	44	1	3
Three months	44	6	3
Electrolytic	49	5	0
Tough	48	10	0
Best selected	49	0	0
Sheets	80	0	0
India	61	12	6
Wire bars	50	5	0
Ingot bars	50	5	0
H.C. wire rods	53	15	0
Off. av. cash, Nov.	45	5	8 23/24
Do., 3 mths., Nov.	45	9	9 1/24
Do., Sttlmnt., Nov.	45	5	8 5/24
Do., Electro, Nov.	51	10	2 5/24
Do., B.S., Nov.	51	4	8 3/4
Do., Wire bars, Nov.	51	18	10 1/24

Solid drawn tubes .. .. 12¾d.
Brazed tubes .. .. 12¾d.
Wire .. .. .. 8¼d.

BRASS

Solid drawn tubes .. 11½d.
Brazed tubes .. .. 13½d.
Rods, drawn .. .. 9½d.
Rods, extd. or rlld. .. .. 5¾d.
Sheets to 10 w.g. .. .. 8¼d.
Wire .. .. .. 8¼d.
Rolled metal .. .. 8¼d.
Yellow metal rods .. .. 5¾d.

TIN

	£	s.	d.
Standard cash	215	7	6
Three months	216	10	0
English	215	12	6
Bars	217	5	0
Straits	221	0	0
Eastern	222	10	0
Banca	219	0	0
Off. av. cash, Nov.	214	0	11 23/24
Do., 3 mths., Nov.	214	17	1 1/24
Do., Sttlmt., Nov.	214	0	0

SPELTER

	£	s.	d.
Ordinary	13	18	9
Remelted	12	5	0
Hard	10	5	0
Electro, 99.9	17	5	0
English	15	5	0
India	14	15	0
Zinc dust	18	15	0
Zinc ashes	5	5	0
Off. aver., Nov.	14	9	1 23/24
Aver., spot, Nov.	14	7	3 1/24

LEAD

	£	s.	d.
Soft foreign, ppt.	14	17	6
Empire (nom.)	16	0	0
English	17	0	0
Sheets, home	22	10	0
Do. export	19	5	0
Pipes, home	22	0	0
Do. export	19	17	6
Tea lead	31	0	0
Off. aver., Nov.	16	3	10 3/24
Aver., spot, Nov.	16	1	9 3/24

ALUMINIUM

Ingots £94
Wire .. .. 1/3 to 1/4 lb.
Sheet and foil .. 1/2½ to 1/4 lb.

ZINC SHEETS, &c.

	£	s.	d.	£	s.	d.
Zinc sheets, English 28	5	0	to 28	15	0	
Do., V.M. ex-whse. 28	5	0	to 28	15	0	
Rods			16	10	0	

ANTIMONY

	£	s.	d.
English	71	0	0
Chinese, ex-whse.	51	0	0
Crude, c.i.f.	37	0	0

QUICKSILVER

Quicksilver 15 2 0

FERRO-ALLOYS AND STEEL-MAKING METALS

Ferro-silicon—
25% 10 10 0
45/50% 12 10 0
75% 17 0 0

Ferro-vanadium—
35/50% .. .. .. 14/- lb. Va.

Ferro-molybdenum—
70/75% carbon-free .. 5/- lb. Mo.

Ferro-titanium—
20/25% carbon-free .. 9d. lb.

Ferro-tungsten—
80/85% .. .. .. 4/8 lb.

Tungsten metal powder—
98/99% .. .. .. 4/9½ lb.

Ferro-chrome—
2/4% car. 34 15 0
4/6% car. 24 5 0
6/8% car. 24 0 0
8/10% car. 24 0 0

Ferro-chrome—
Max. 2% car. 36 0 0
Max. 1% car. 38 5 0
Max. 0.5% car. 41 0 0
70% carbon-free .. 10d. lb.

Nickel—99.5/100% ..£180 to £185
"F" nickel shot £165 0 0

Ferro-cobalt, 98/99% ..8/6 to 8/9 lb.

Metallic chromium—
96/98% .. .. .. 2/5 lb.

Ferro-manganese—
76/80% loose £16 15 0 to 17 5 0
76/80% packed £17 15 0 to 18 5 0
76/80% export (nom.) .. £16 15 0

Metallic manganese—
94/96% carbon-free .. 1/3 lb.
Per ton unless otherwise stated, basis 2-ton lots, d/d Sheffield works.

SCRAP

	£	s.	d.	£	s.	d.
South Wales (West)—						
Heavy steel, best	3	8	9 to	3	11	3
Mixed iron and steel ..	3	6	9 to	3	9	3
Heavy cast iron	3	8	9 to	3	11	3
Good machinery	3	10	0 to	3	12	6
Cleveland—						
Heavy steel, best	3	7	0 to	3	9	6
Heavy cast iron			..	3	12	6
Heavy machinery			..	4	0	0
Midlands—						
Short heavy steel			..	3	7	6
Light cast-iron scrap			..	2	15	0
Heavy wrought iron	3	7	6 to	3	10	0
Steel turnings	2	6	3 to	2	8	9
Scotland—						
Heavy steel, best	3	5	0 to	3	7	6
Ordinary cast iron	3	12	6 to	3	13	6
Cast-iron borings	2	0	6 to	2	3	0
Wrot-iron piling	3	15	0 to	3	17	6
Heavy machinery	3	17	6 to	3	18	6

London—Merchants' buying prices, delivered yard.

	£	s.	d.
Copper (clean)	34	0	0
Brass	20	0	0
Lead (less usual draft)	13	10	0
Tea lead	11	0	0
Zinc	8	10	0
New aluminium cuttings	59	0	0
Braziery copper	32	0	0
Gunmetal	35	0	0
Hollow pewter	135	0	0
Shaped black pewter	96	0	0

HIGH-SPEED TOOL STEEL

Finished bars, 14% tungsten 3s. 0d.
Finished bars, 18% tungsten 3s. 10d.
Per lb. d/d buyers' works.

PIG-IRON*

N.E. Coast (d/d Tees-side area)—
Foundry No. 1 .. .. 111/6
„ No. 3 .. .. 109/-
„ No. 4 .. .. 108/-
Forge No. 4 .. .. 108/-
Hematite No. 1 .. .. 133/-
Hematite M/Nos. 132/6

N.W. Coast—
Hem. M/Nos. d/d Glas. .. 133/-
„ d/d Birm. 144/6

Midlands (d/d Birmingham dist.)—
Staffs No. 4 forge 110/-
„ No. 3 fdry. 111/-
Northants forge 107/6
„ fdry. No. 3 .. 108/6
„ fdry. No. 1 .. 111/6
Derbyshire forge 110/-
„ fdry. No. 3 .. 111/-
„ fdry. No. 1 .. 114/-

Scotland—
Foundry, No. 1, f.o.t. .. 120/6
„ No. 3, f.o.t. .. 118/-
Cleveland No. 3, Glasgow 112/-
„ „ Falkirk .. 109/-
Scottish hem. M/Nos. d/d 133/-

Sheffield (d/d district)—
Derby forge 107/6
„ fdry. No. 3 .. 108/6
Lincs forge 107/6
„ fdry. No. 3 .. 108/6
W.C. hematite 138/6

Lancashire (d/d eq. Man.)—
Derby fdry. No. 3 .. 114/-
Staffs fdry. No. 3 .. 114/-
Northants fdry. No. 3 .. 112/6
Cleveland fdry. No. 3 .. 114/-
Glengarnock, No. 3 .. 135/-
Clyde, No. 3 .. .. 135/-
Monkland, No. 3 .. .. 135/-
Eglinton, No. 3 .. .. 135/-
Gartsherrie, No. 3 .. 135/-
Shotts, No. 3 .. .. 135/-

(* Prices of hematite and basic pig-iron, and of foundry and forge iron with a phosphoric content of not less than 0.75 per cent., are subject to a rebate of 5s. per ton under certain conditions.)

FINISHED IRON AND STEEL

Usual district deliveries.

[A rebate of 15/- per ton for steel bars, sections, plates, joists and hoops is obtainable in the home trade under certain conditions.]

Iron—	£	s.	d.	£	s.	d.
Bars (cr.)	13	5	0 to	13	15	0
Nut and bolt iron	11	12	6 to	12	2	6
Hoops			..	14	2	6
Marked bars (Staffs) f.o.t.				15	15	0
Gas strip			..	14	2	6
Bolts and nuts, ¾ in. × 4 in.				17	10	0 and up
Steel—						
Plates, ship, etc.	11	8	0 to	11	10	6
Boiler plts.	11	18	0 to	12	0	6
Angles			..	11	0	6
Tees			..	12	0	6
Joists			..	11	0	6
Rounds and squares, 3 in. to 5½ in.			..	12	0	6
Rounds under 3 in. to ⅜ in. (untested)			..	12	4	0
Flats—8 in. wide and over				11	5	6
„ under 8 in. and over 5 in.				11	10	6
Rails, heavy			..	10	2	6
Fishplates			..	14	2	6
Hoops (Staffs)			..	12	19	0
Black sheets, 24g. (4-t. lots)				15	15	0
Galv. cor. shts. („)				18	10	0
Galv. flat shts. („)				19	0	0
Galv. fencing wire, 8g. plain				20	5	0
Billets, soft, 100-ton lots			..	7	17	6
Sheet bars			..	7	15	0
Tin bars			..	7	15	0

PHOSPHOR BRONZE

Per lb. basis

Strip .. .. 11¼d.
Sheet to 10 w.g. .. .. 11¾d.
Wire .. .. 13¾d.
Rods .. .. 13¾d.
Tubes .. .. 19d.
Castings .. .. .. 15d.

Delivery 3 cwt. free.
10% phos. cop. £33 above B.S.
15% phos. cop. £38 above B.S.
Phosphor tin (5%) £30 above price of English ingots.
C. CLIFFORD & SON, LIMITED.

NICKEL SILVER, &c.

Per lb.

Ingots for raising .. 7d. to 1/1
Rolled—
To 9 in. wide .. 1/1 to 1/7
To 12 in. wide .. 1/1½ to 1/7½
To 15 in. wide .. 1/1½ to 1/7½
To 18 in. wide .. 1/2 to 1/8
To 21 in. wide .. 1/2½ to 1/8½
To 25 in. wide .. 1/3 to 1/9
Ingots for spoons and forks 7d. to 1/3½
Ingots rolled to spoon size 10d. to 1/6½
Wire round—
to 10g. .. .. 1/4½ to 1/11½
with extras according to gauge.
Special 5ths quality turning rods in straight lengths, 1/3½ upwards.

AMERICAN IRON AND STEEL

At Pittsburgh unless otherwise stated.

Dols.

No. 2 foundry, Phila. 22.84
No. 2 foundry, Valley 21.00
No. 2 foundry, Birm. 17.38
Basic, Valley 20.50
Malleable, Valley 21.00
Grey forge, Valley 20.50
Ferro-mang. 80%, seaboard .. 92.50
O.-h. rails, h'y, at mill .. 40.00
Billets 34.00
Sheet bars 34.00
Wire rods 43.00

Cents

Iron bars, Chicago 2.15
Steel bars 2.25
Tank plates 2.10
Beams, etc. 2.10
Skelp, grooved steel 1.90
Steel strip 2.15
Sheets, galv., No. 24 .. .. 3.50
Wire nails 2.45
Plain wire 2.60
Barbed wire, galv. 3.20
Tinplates, 100-lb. box $5.00

COKE (at ovens)

Welsh foundry .. .. 38/- to 41/6
„ furnace 27/6
Durham foundry 34/6
„ furnace 27/6
Scottish foundry 30/-
„ furnace 27/6

TINPLATES

f.o.b. British Channel ports.

I.C. cokes 20×14 per box 20/3 to 21/6
„ 28×20 „ 40/6 to 43/-
„ 20×10 „ .. 20/-
„ 18¾×14 „ .. 21/-
C.W. 20×14 „ 19/- to 20/3
„ 28×20 „ 38/- to 40/6
„ 20×10 „ .. 27/-
„ 18¾×14 „ .. 19/3

SWEDISH CHARCOAL IRON & STEEL

Pig-iron .. £9 0 0 to £10 0 0
Bars-hammered, basis .. £19 0 0 to £20 0 0
Bars and nail-rods, rolled, basis .. £19 0 0 to £20 0 0
Blooms .. £17 10 0 to £18 0 0
Keg steel .. £27 0 0 to £30 0 0
Faggot steel £19 0 0 to £24 0 0
Bars and rods dead soft st'l £12 0 0 to £15 0 0
All per English ton, f.o.b. Gothenburg [Subject to an exchange basis of Kr. 19.39 to £1.]

DAILY FLUCTUATIONS

Standard Copper (cash)

		£ s. d.	
Dec. 21	..	44 0 0 inc.	6/3
„ 22	..	43 17 6 dec.	2/6
„ 23	..	43 18 9 inc.	1/3
„ 28	..	44 1 3 „	2/6

Electrolytic Copper

		£ s. d.	
Dec. 21	..	49 10 0 No	change
„ 22	..	49 10 0 „	„
„ 23	..	49 5 0 dec.	5/-
„ 28	..	49 5 0 No	change

Standard Tin (cash)

		£ s. d.		
Dec. 21	..	214 0 0 inc.	5/-
„ 22	..	214 10 0 „	10/-
„ 23	..	215 0 0 „	10/-
„ 28	..	215 7 6 „	7/6

Tin (English ingots)

		£ s. d.		
Dec. 21	..	214 0 0 inc.	5/-
„ 22	..	214 15 0 „	15/-
„ 23	..	215 5 0 „	10/-
„ 28	..	215 12 6 „	7/6

Spelter (ordinary)

		£ s. d.		
Dec. 21	..	13 17 6 inc.	5/-
„ 22	..	14 1 3 „	3/9
„ 23	..	13 18 9 dec.	2/6
„ 28	..	13 18 9 No	change

Spelter (Electro, 99.9 per cent.)

		£ s. d.		
Dec. 21	..	17 5 0 inc.	5/-
„ 22	..	17 10 0 „	5/-
„ 23	..	17 5 0 dec.	5/-
„ 28	..	17 5 0 No	change

Lead (soft foreign, prompt)

		£ s. d.		
Dec. 21	..	15 2 6 inc.	3/9
„ 22	..	15 1 3 dec.	1/3
„ 23	..	15 2 6 inc.	1/3
„ 28	..	14 17 6 dec.	5/-

Lead (English)

		£ s. d.		
Dec. 21	..	17 5 0 inc.	5/-
„ 22	..	17 5 0 No	change
„ 23	..	17 5 0 „	„
„ 28	..	17 0 0 dec.	5/-

AVERAGE MONTHLY PRICES OF CLEVELAND No. 3 PIG-IRON.*

Year	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Yearly average
	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.
1898	40 9	40 8	40 6	40 0	40 7	39 11	40 4	41 11	43 0	44 11	49 1	44 3	43 0
1899	46 10	47 11	47 9	49 10	55 11	62 10	71 6	65 9	67 7	68 8	70 0	66 9	60 8
1900	67 10	68 10	73 10	76 2	74 2	68 6	69 3	71 4	70 9	67 8	63 6	53 6	68 9
1901	48 0	46 6	45 8	45 5	45 10	44 7	44 6	45 3	45 3	45 3	43 6	43 1	45 3
1902	43 11	46 7	46 9	47 11	48 10	49 7	50 9	52 1	53 6	52 9	50 9	47 11	49 3
1903	47 3	48 9	51 10	49 0	46 1	46 2	46 7	46 8	45 7	43 6	42 10	41 11	46 4
1904	42 3	42 7	43 3	44 7	44 0	42 10	42 9	42 3	43 1	43 9	46 1	48 7	43 11
1905	48 11	48 0	49 6	50 1	51 5	45 6	45 9	47 5	48 8	52 11	52 9	53 3	49 6
1906	53 9	50 1	48 1	48 8	50 2	50 3	50 6	53 0	54 6	58 8	58 6	62 4	53 6
1907	60 4	56 6	54 10	56 0	61 1	58 1	57 8	57 8	55 7	54 8	50 8	50 0	56 2
1908	48 5	49 3	51 7	51 10	51 6	51 2	50 0	51 4	52 0	49 8	49 4	48 11	50 8
1909	48 10	48 [illegible]	46 9	47 9	48 4	48 9	48 6	50 5	51 3	51 11	51 2	50 7	49 4
1910	51 10	51 3½	51 7½	50 10	49 10	49 2	48 10	49 8½	49 3½	49 7½	49 6½	49 10	50 4
1911	49 11½	49 2½	48 5	46 11	46 4	46 6	46 11½	47 4	47 0	46 7	47 4½	48 1	47 7
1912	50 0	49 5½	51 1½	53 7½	54 4	55 1	57 5½	64 6½	61 7½	66 8½	67 8	68 0	58 8½
1913	66 11½	63 8½	64 8	67 1½	66 3	56 9½	56 3½	55 8	55 4	53 0	50 1	50 4	58 10
1914	50 11	51 5½	51 0½	51 4½	51 6	51 6½	51 5	52 3	51 5	50 1	50 3	53 0	51 4½
1915	55 7	56 6	61 0	66 7	65 2	66 10	65 4	66 0½	65 3	65 11	69 10½	75 7½	65 7
1916	80 2	91 6	87 4½	86 10	82 6	82 6	87 6	87 6	87 6	87 6	87 6	87 6	85 10
1917	87 6	87 6	87 6	92 6	92 6	92 6	92 6	92 6	92 6	92 6	92 6	95 0	90 3
1918	95 0	95 0	95 0	95 0	95 0	95 0	95 0	95 0	95 0	95 0	95 0	95 0	95 0
1919	95 0	95 0	95 0	95 0	152 6	160 0	160 0	160 0	160 0	160 0	160 0	160 0	137 8
1920	175 0	175 0	187 6	200 0	208 0	217 6	217 6	221 0	225 0	225 0	225 0	225 0	209 3
1921	222 6	195 0	150 0	126 0	120 0	120 0	120 0	136 3	127 0	120 0	110 0	100 0	137 4
1922	92 6	90 0	90 0	90 0	90 0	90 0	89 0	87 3	92 6	92 6	92 6	91 3½	90 7½
1923	94 6	108 9	125 6	129 4½	128 5	136 0	128 1½	121 11	97 1½	97 0	100 0	100 0	110 6½
1924	99 10	97 3½	91 9	93 9	91 9	89 10½	87 9	85 0	82 5½	80 2½	81 9	81 9	88 7½
1925	80 4½	78 10½	78 0	78 3	76 0	73 10½	71 7½	69 10½	68 1½	66 7½	66 0	66 10½	72 10½
1926	69 4½	70 0	70 0	70 0	72 6	75 10½	86 7½	90 0	93 10½	117 10	120 0	99 0	86 3
1927	85 0	83 1½	81 0	80 0	73 9	70 0	70 0	68 9	67 6	67 6	66 10½	65 0	73 3½
1928	65 0	65 0	65 6	66 0	66 0	66 0	66 0	66 0	66 0	66 0	66 0	66 0	65 9½
1929	66 0	66 9	67 0	68 1½	69 5	71 10½	72 9	72 6	72 6	72 6	72 6	72 6	70 4½
1930	72 6	72 6	70 0	67 6	67 6	67 6	67 6	64 6	63 6	63 6	63 6	63 6	66 11½
1931	59 6	58 6	58 6	58 6	58 6	58 6	58 6	58 6	58 6	58 6	58 6	58 6	58 7
1932	58 6	58 6	58 6	58 6	58 6	58 6	58 6	58 6	58 6	58 6	58 6	58 6	58 6
1933	62 6	62 6	62 6	62 6	62 6	62 6	62 6	62 6	62 6	62 6	62 6	62 6	62 6
1934	62 6	65 0	67 6	67 6	67 6	67 6	67 6	67 6	67 6	67 6	67 6	67 6	66 10½
1935	67 6	67 6	67 6	67 6	67 6	67 6	67 6	67 6	67 6	67 6	69 4½	70 0	67 10½
1936	70 0	70 0	70 0	70 0	70 0	70 0	75 0	75 0	75 0	75 0	75 0	81 0	73 0
1937	81 0	81 0	81 0	81 0	81 0	101 0	101 0	101 0	101 0	101 0	106 0	106 0	91 10
1938	109 0	109 0	109 0	109 0	109 0	109 0	109 0	109 0	109 0	109 0	109 0	109 0	109 0

*Delivered Middlesbrough area for years 1933 and onwards. Prior to 1913, prices were f.o.t. furnaces. NOTE: Prices have been subject to a rebate of 5/- per ton since November 1, 1937.

WILLIAM JACKS & COMPANY,
WINCHESTER HOUSE, OLD BROAD ST., LONDON, E.C.2.

CLARENCE CHAMBERS, 39, CORPORATION STREET, BIRMINGHAM.
13, RUMFORD STREET, LIVERPOOL.

PIG IRON

REGISTERED TRADE MARK
LUMPEX

All grades FOUNDRY, HEMATITE, BASIC, SPECIALS, &c.

NON-FERROUS METALS

COPPER, TIN, LEAD, SPELTER, ANTIMONY, CHROME ORE.

WILLIAM JACKS & COMPANY,
CENTRAL CHAMBERS, 93, HOPE ST., GLASGOW, C.2.
ZETLAND ROAD, MIDDLESBROUGH.

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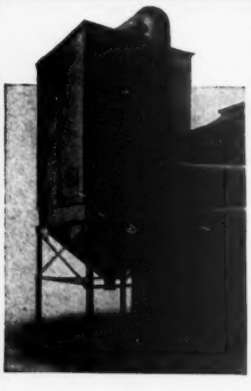

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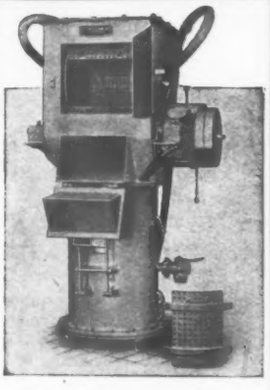

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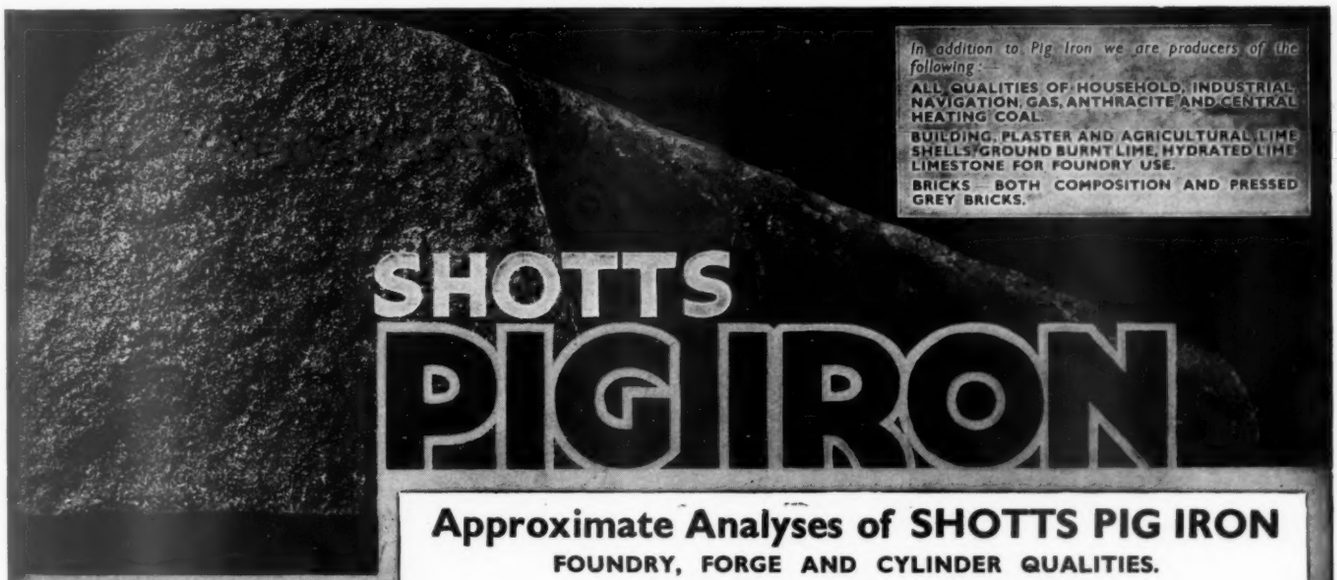

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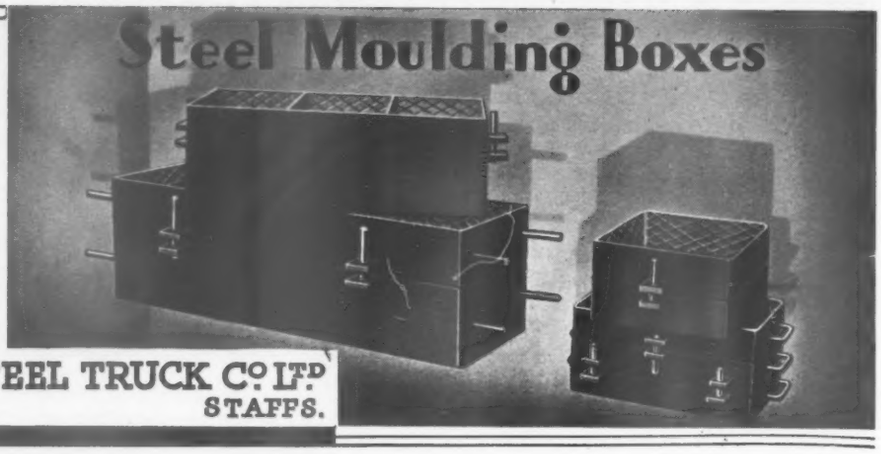

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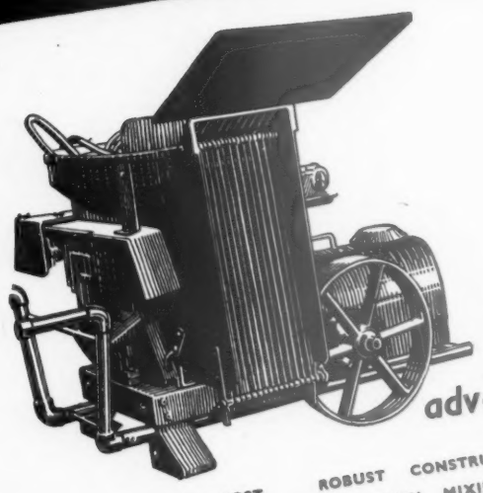

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